Utah Department of Transportation
Traffic Management Division

August 2016

Monthly Report

Keeping Utah Moving

2060 South 2760 West   Salt Lake City, Utah 84104   801-887-3710   **www.udottraffic.utah.gov**

Mission of the Traffic Management Division

•To Support UDOT and the Department of Public Safety to Achieve Zero Fatalities.

•To Help Provide Reliable and Efficient Travel Throughout Utah.

•To Provide Useful and Timely Real-time Traffic Information.

•To Work Together with Other Government Agencies to Serve the Public.

•To Provide Excellent Customer Service.

Field Devices Summary

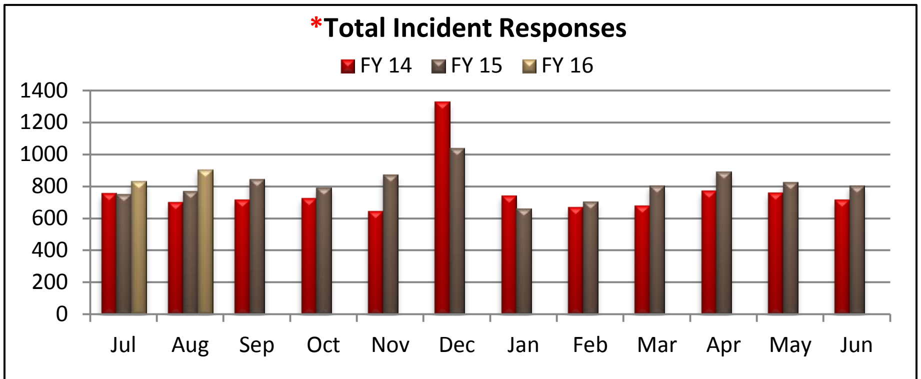
Freeway PTZ Cameras	392	Freeway VMS	100
Arterial PTZ Cameras	482	Surface Street VMS	58
RWIS & Contracted Weather Cameras	214	Portable TOC VMS	7
Viewable Detection Cameras	54	Legacy Trucks Prohibited VMS	21
Total Cameras	1,142	Variable Speed Limit VMS	15
HAR (27 permanent/5 portable)	32	Chain-Up/Avalanche Warning Signs	21
RWIS	100	Total VMS	222
Ramp Meters	68	TMS	577
Express Lane Plazas	73	Traffic Signals	2,181

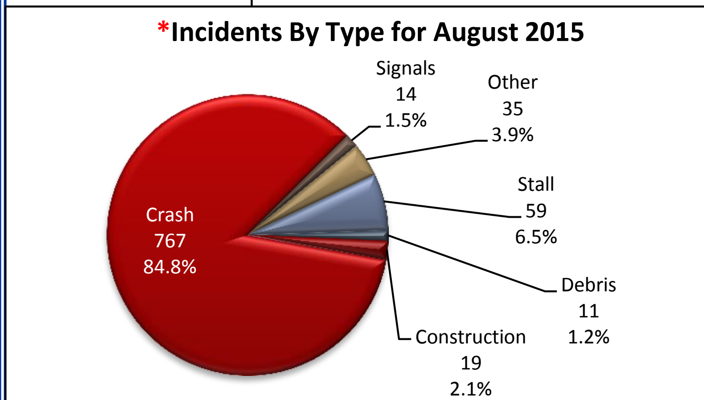
Operations Summary

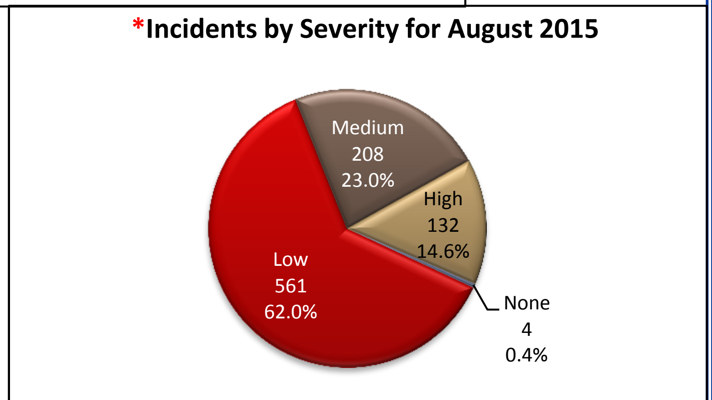
VMS Messages Displayed	84,041	IMT Assists	2,833
Signal Timing Work Orders	56	Website Visitor Sessions	107,172
Signal Maintenance Work Orders	154	511 Calls	10,663
All New Work Orders	491	Weather Desk Calls	148
Incident Responses by the TOC	905	Ask CommuterLink Questions	73
Incident Duration Average Minutes	58	UDOT Traffic Followers and Re-tweets	390,638

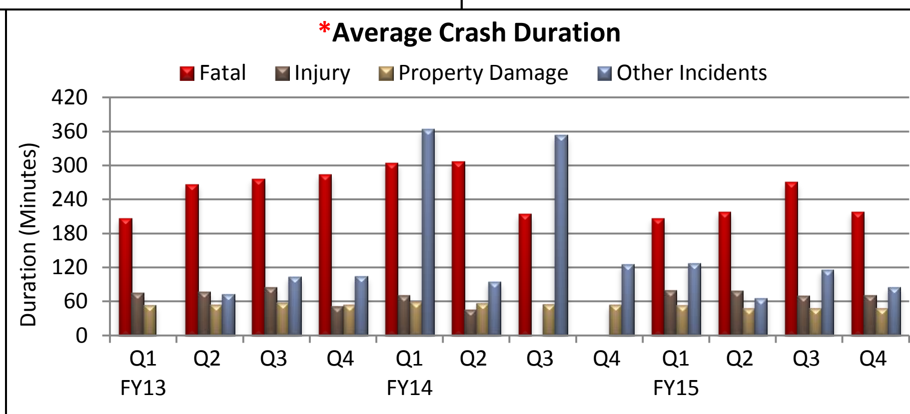
Safety – *Note: Due to a server change. No safety data has been captured since August 2015

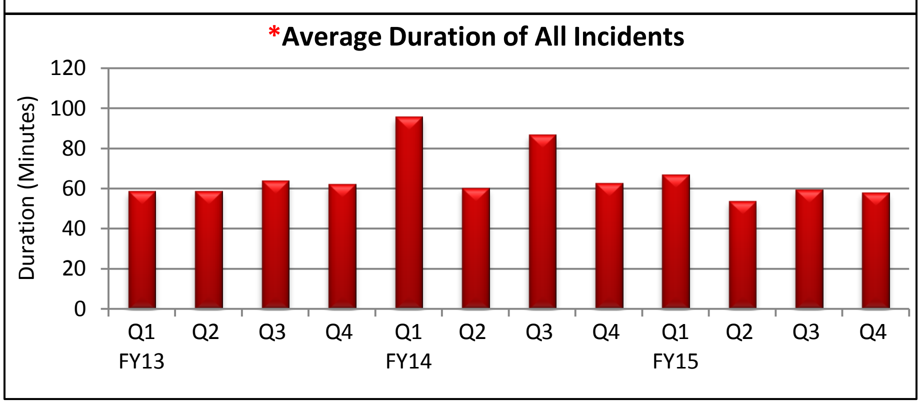
An incident response occurs each time an incident is recorded in the ATMS system. These can be of several types, including crash, construction, debris, stall, congestion, or other. Crashes are separated into three subcategories: property damage, personal injury, and fatal. Each time an incident is created, information is sent to the 511 system, the website, and to the public through email alerts. An incident remains active until it has been completely cleared from the roadway.

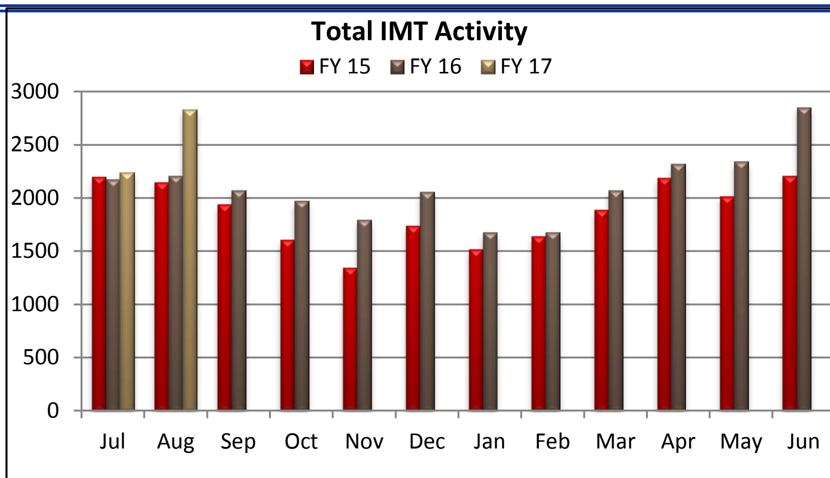


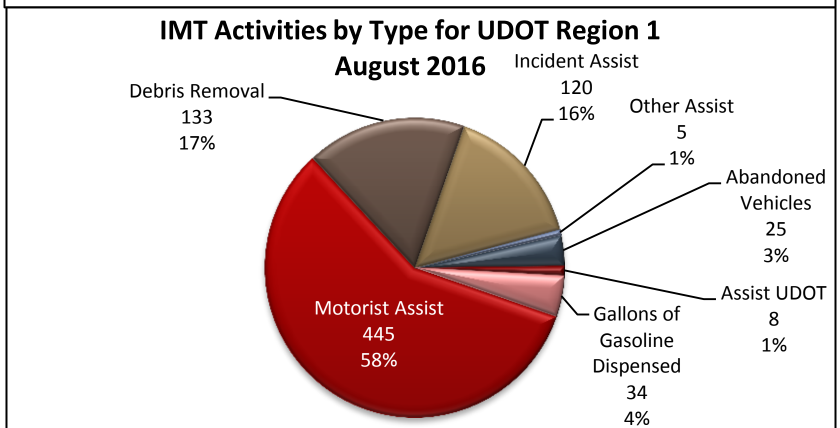


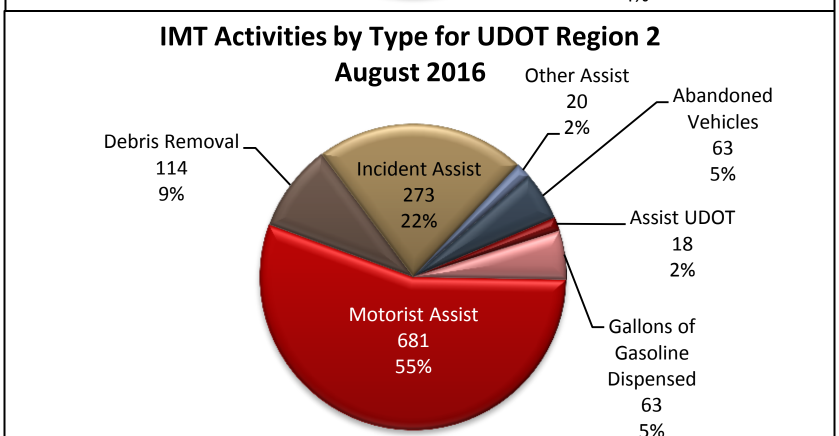


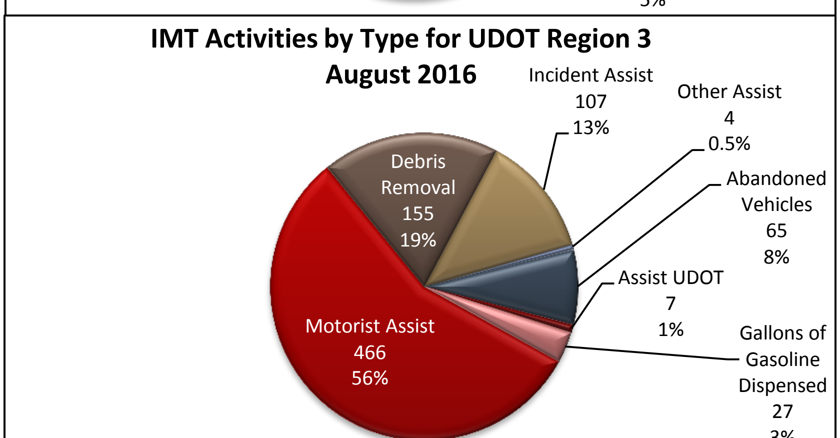





Total IMT Activity
FY 15
FY 16
FY 17
3000
2500
2000
1500
1000
500
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun


IMT Activities by Type for UDOT Region 1
August 2016
Incident Assist 120 16%
Debris Removal 133 17%
Other Assist 5 1%
Abandoned Vehicles 25 3%
Assist UDOT 8 1%
Gallons of Gasoline Dispensed 34 4%
Motorist Assist 445 58%


IMT Activities by Type for UDOT Region 2
August 2016
Other Assist 20 2%
Abandoned Vehicles 63 5%
Debris Removal 114 9%
Incident Assist 273 22%
Assist UDOT 18 2%
Motorist Assist 681 55%
Gallons of Gasoline Dispensed 63 5%


IMT Activities by Type for UDOT Region 3
August 2016
Incident Assist 107 13%
Other Assist 4 0.5%
Debris Removal 155 19%
Abandoned Vehicles 65 8%
Assist UDOT 7 1%
Motorist Assist 466 56%
Gallons of Gasoline Dispensed 27 3%

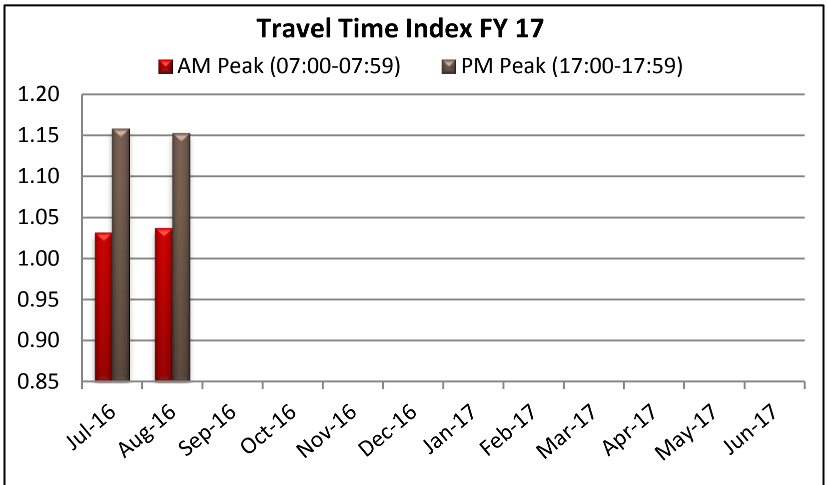
Freeway Traffic Level of Service

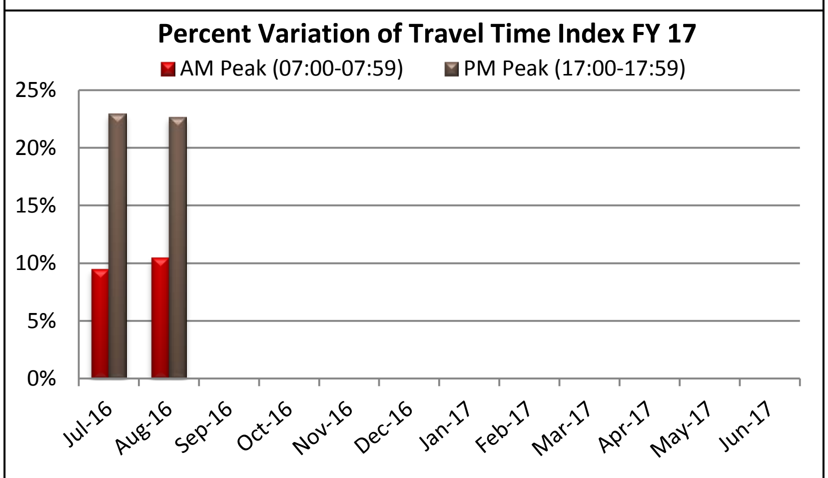
Freeway flow measures are taken from the Traffic Monitoring Stations (TMS) located throughout the Wasatch Front. As more TMS sites are installed throughout the state, they will be included in these performance measures.

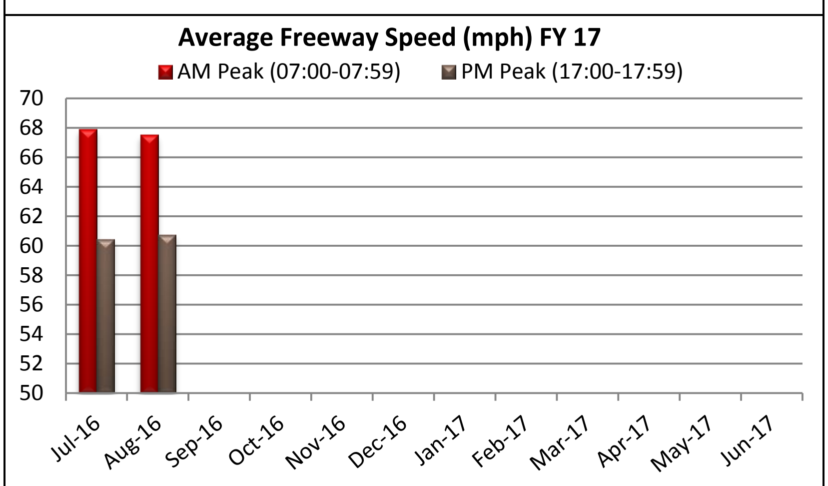
Travel Time Index: This measure of mobility is based on freeway speeds and is weighted by segment lengths and by the traffic volume. A value of 1.0 represents free-flow speeds. A value of 1.12 indicates that the average vehicle trip takes 12% longer than if that were the only vehicle on the freeway.

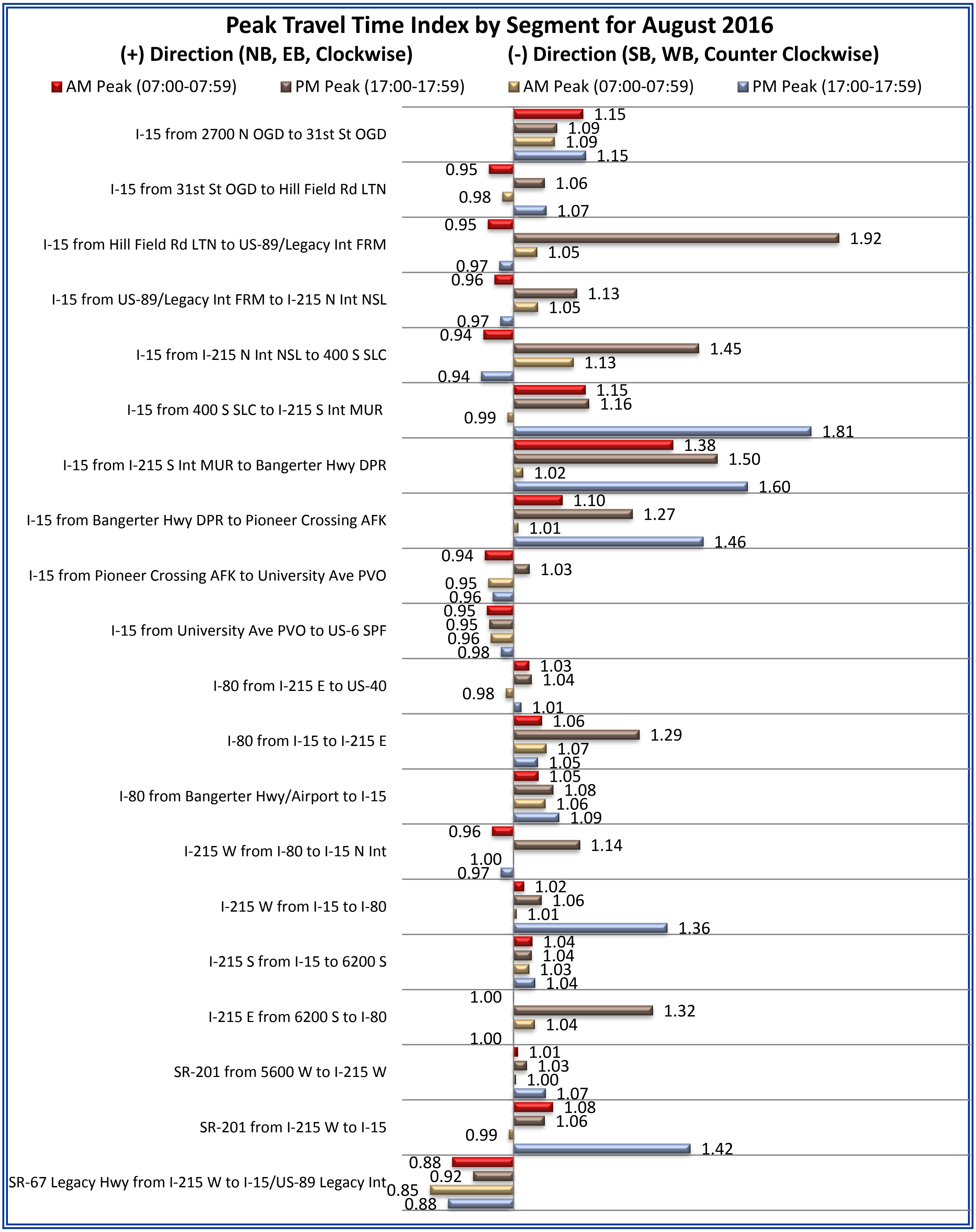
Percent Variation of Travel Time Index: The percent variation in the Travel Time Index is a measure of how much the Travel Time Index changes from day-to-day.

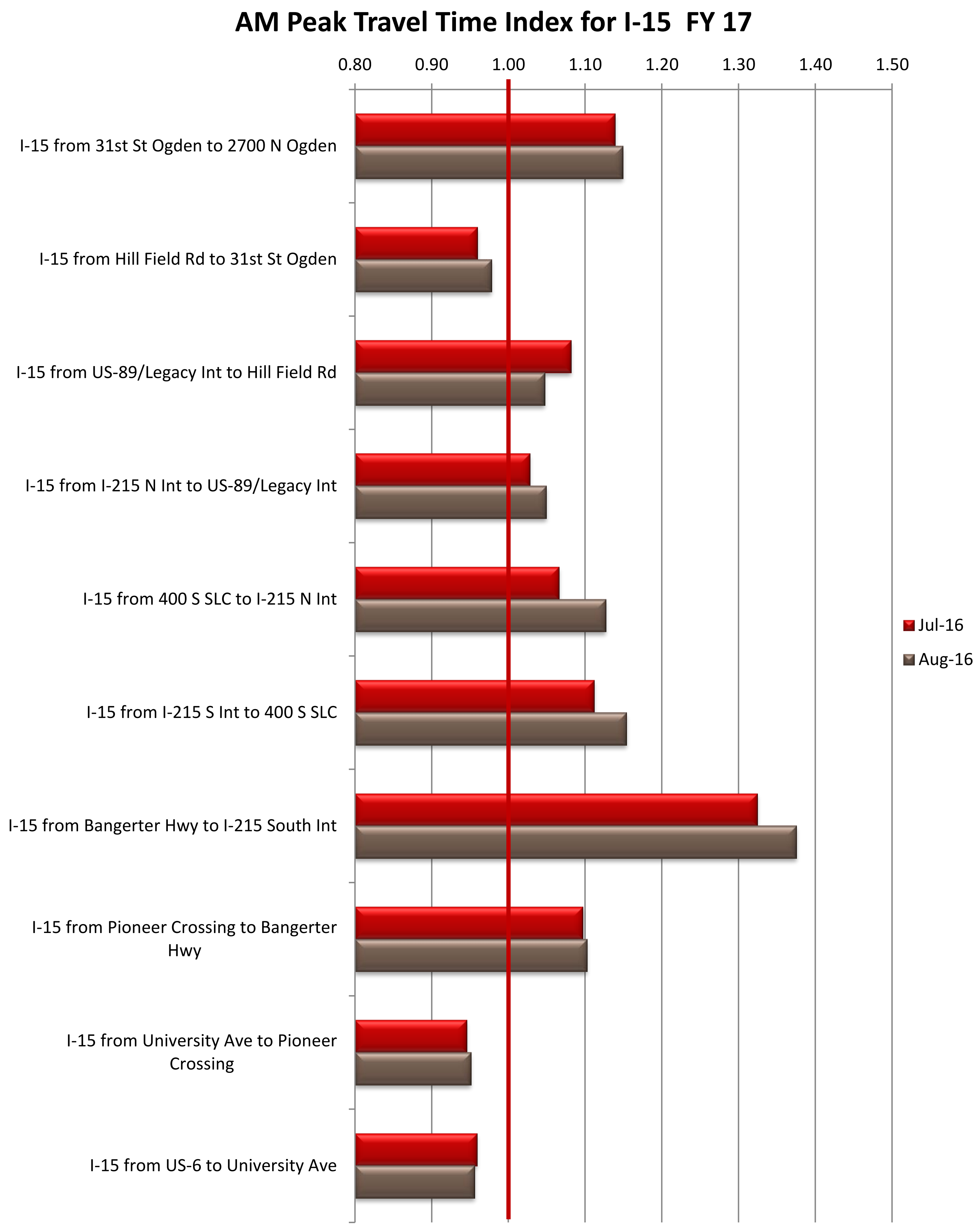
Average Freeway Speed: The freeway speed is weighted by volume.

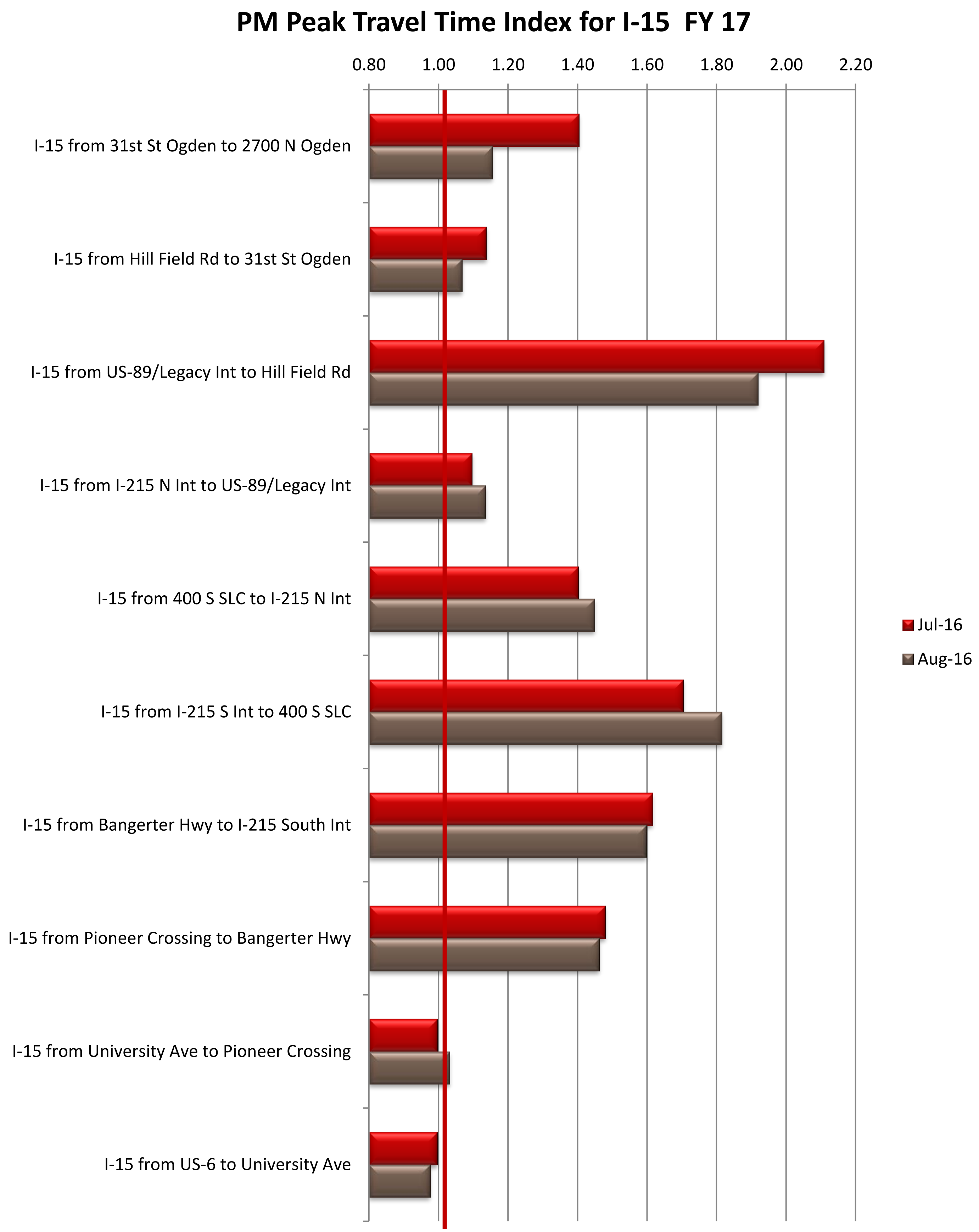


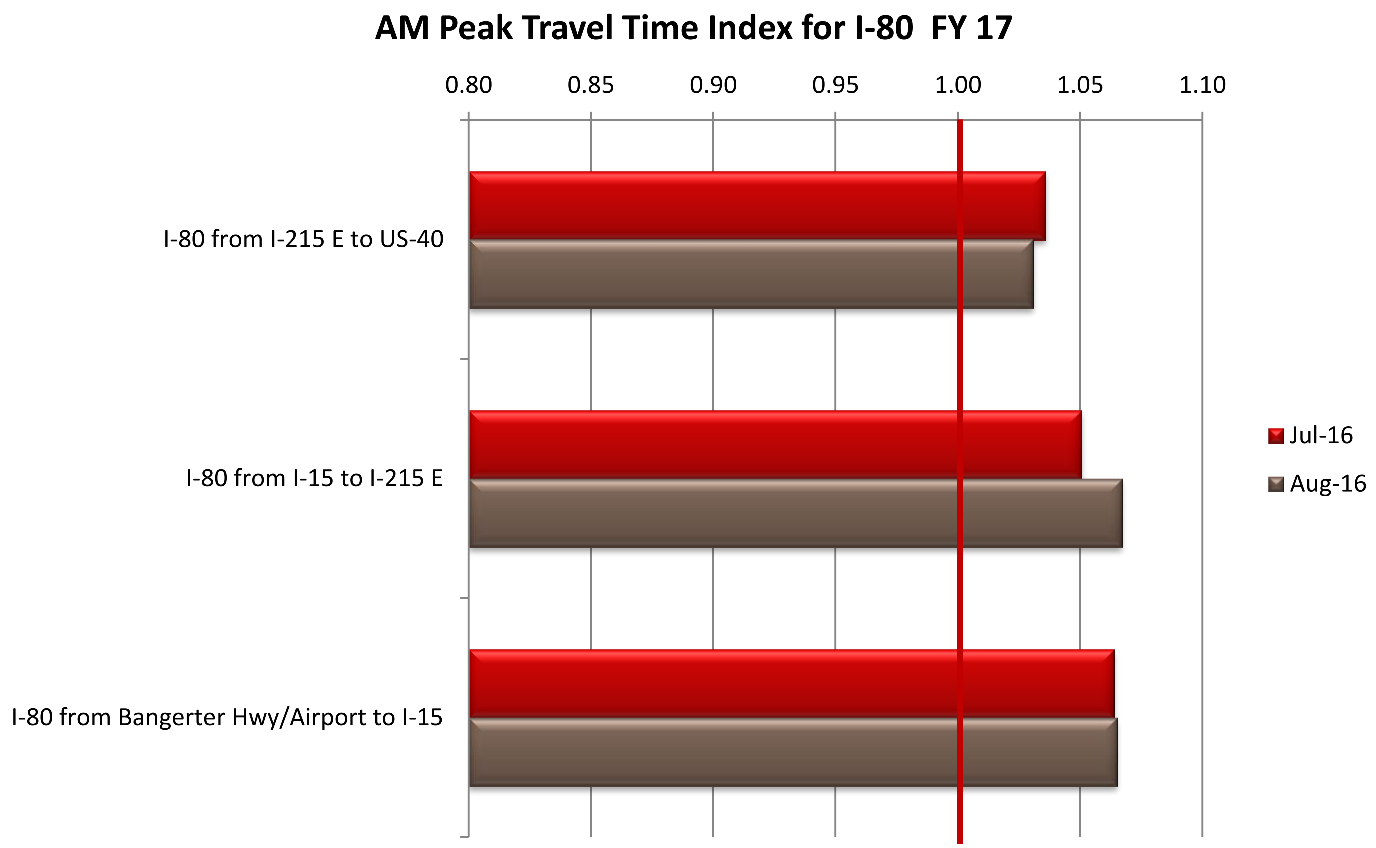


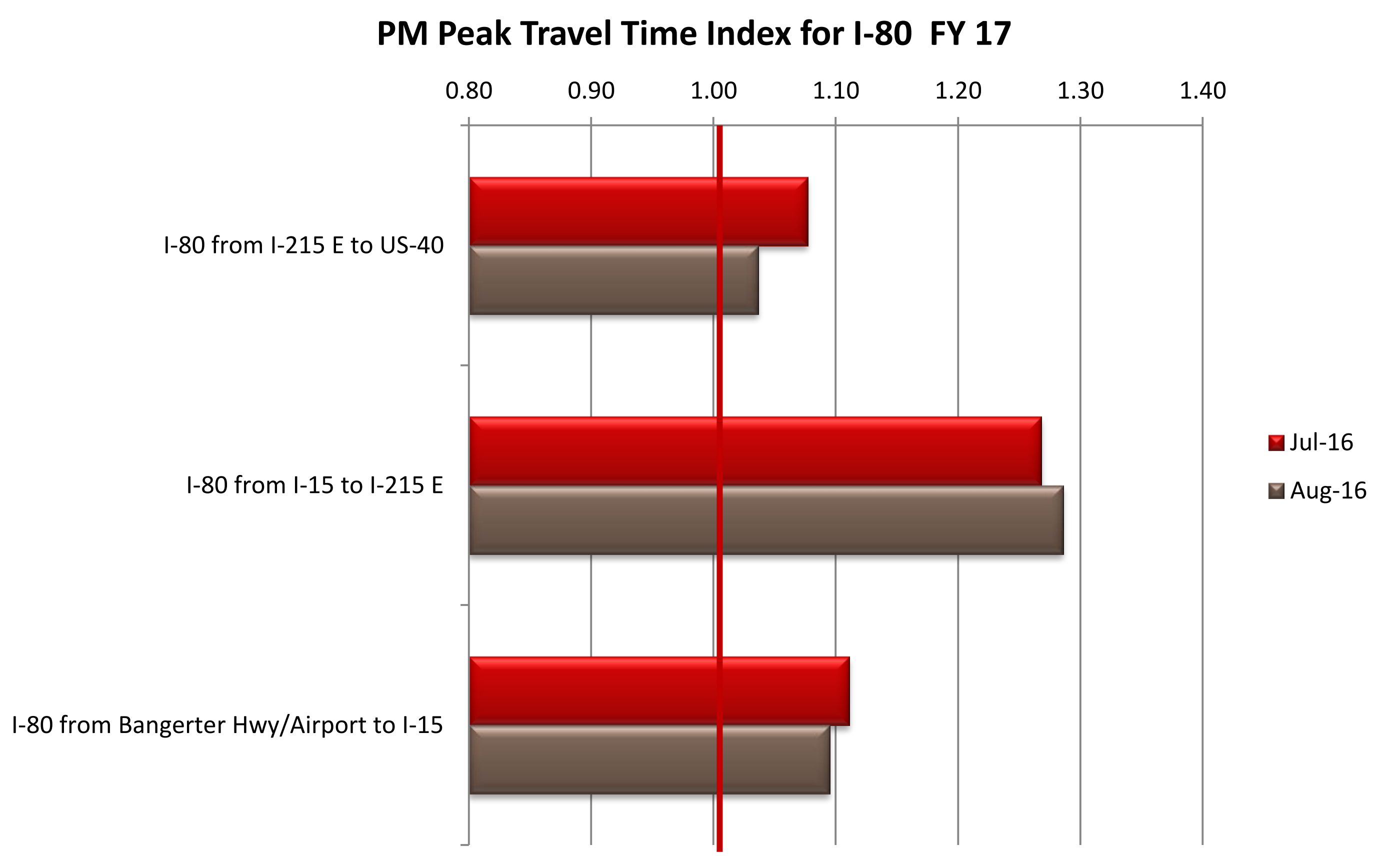


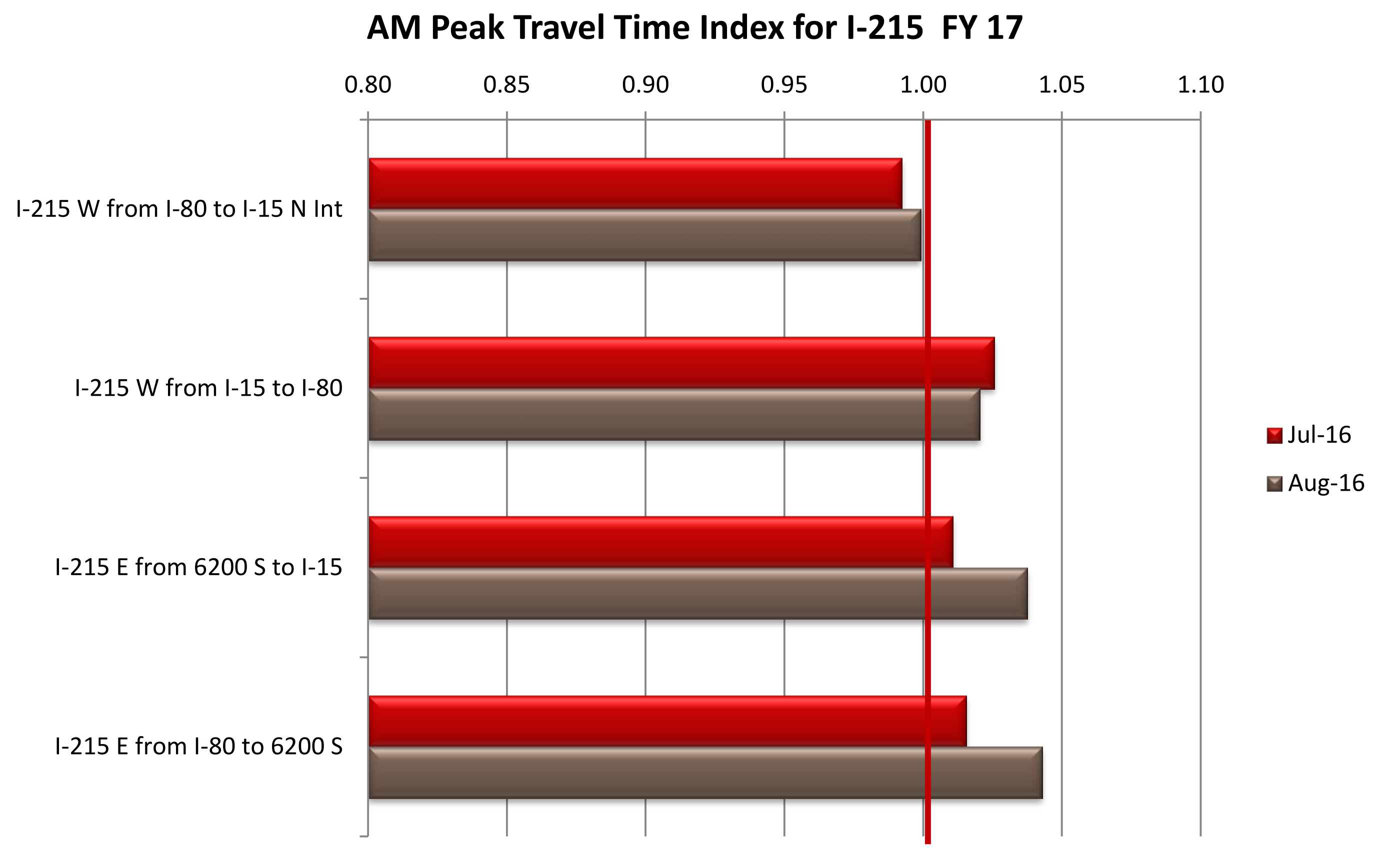

Peak Travel Time Index by Segment for August 2016
(+) Direction (NB, EB, Clockwise)
(-) Direction (SB, WB, Counter Clockwise)
AM Peak (07:00-07:59)
PM Peak (17:00-17:59)
AM Peak (07:00-07:59)
PM Peak (17:00-17:59)
I-15 from 2700 N OGD to 31st St OGD
1.15
1.09
1.09
1.15
I-15 from 31st St OGD to Hill Field Rd LTN
0.95
1.06
0.98
1.07
I-15 from Hill Field Rd LTN to US-89/Legacy Int FRM
0.95
1.92
1.05
0.97
I-15 from US-89/Legacy Int FRM to I-215 N Int NSL
0.96
1.13
1.05
0.97
I-15 from I-215 N Int NSL to 400 S SLC
0.94
1.45
1.13
0.94
I-15 from 400 S SLC to I-215 S Int MUR
1.15
1.16
0.99
1.81
I-15 from I-215 S Int MUR to Bangerter Hwy DPR
1.38
1.50
1.02
1.60
I-15 from Bangerter Hwy DPR to Pioneer Crossing AFK
1.10
1.27
1.01
1.46
I-15 from Pioneer Crossing AFK to University Ave PVO
0.94
1.03
0.95
0.96
I-15 from University Ave PVO to US-6 SPF
0.95
0.95
0.96
0.98
I-80 from I-215 E to US-40
1.03
1.04
0.98
1.01
I-80 from I-15 to I-215 E
1.06
1.29
1.07
1.05
I-80 from Bangerter Hwy/Airport to I-15
1.05
1.08
1.06
1.09
I-215 W from I-80 to I-15 N Int
0.96
1.14
1.00
0.97
I-215 W from I-15 to I-80
1.02
1.06
1.01
1.36
I-215 S from I-15 to 6200 S
1.04
1.04
1.03
1.04
I-215 E from 6200 S to I-80
1.00
1.32
1.04
1.00
SR-201 from 5600 W to I-215 W
1.01
1.03
1.00
1.07
SR-201 from I-215 W to I-15
1.08
1.06
0.99
1.42
SR-67 Legacy Hwy from I-215 W to I-15/US-89 Legacy Int
0.88
0.92
0.85
0.88

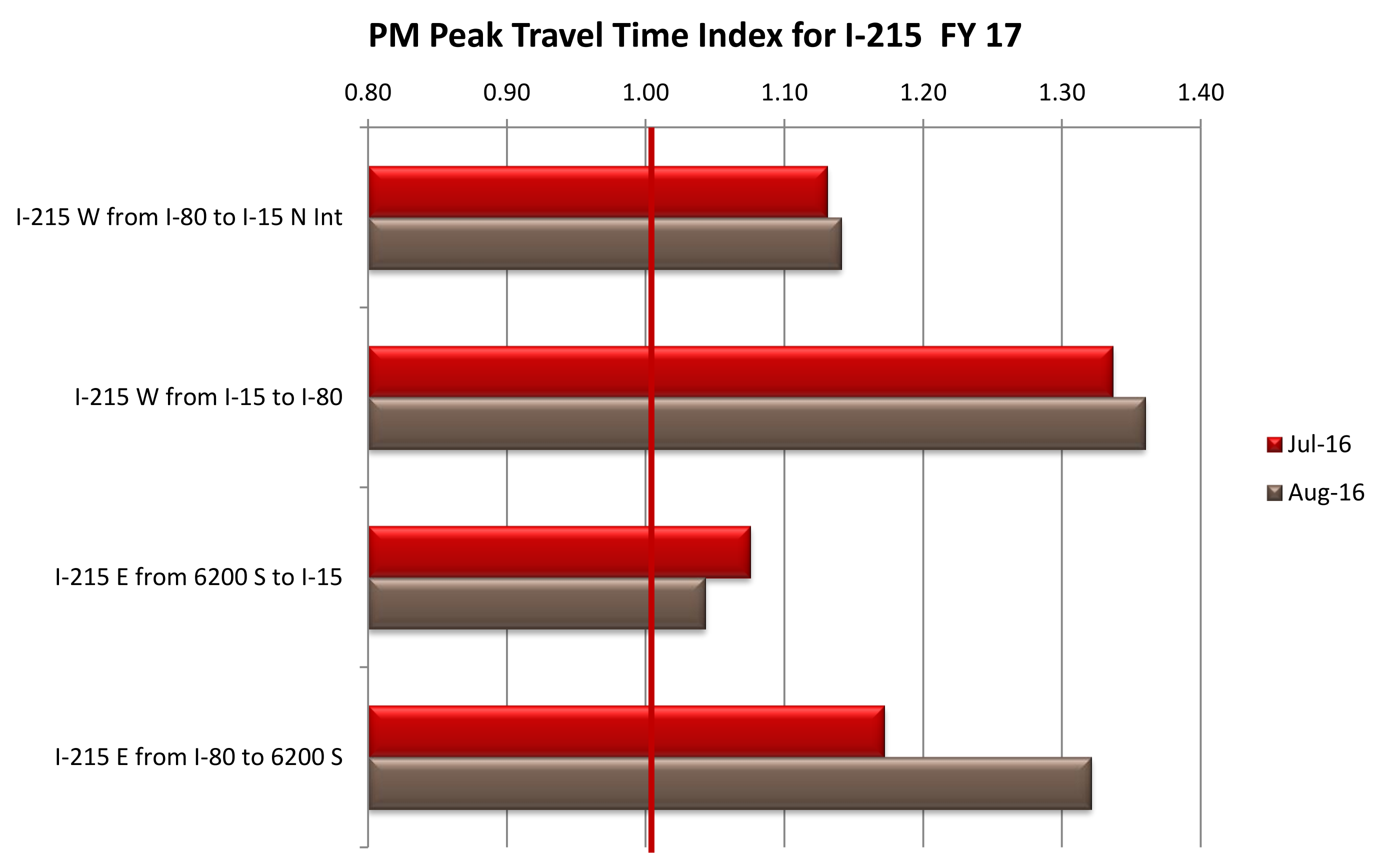

AM Peak Travel Time Index for I-15 FY 17
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
I-15 from 31st St Ogden to 2700 N Ogden
I-15 from Hill Field Rd to 31st St Ogden
I-15 from US-89/Legacy Int to Hill Field Rd
I-15 from I-215 N Int to US-89/Legacy Int
I-15 from 400 S SLC to I-215 N Int
I-15 from I-215 S Int to 400 S SLC
I-15 from Bangerter Hwy to I-215 South Int
I-15 from Pioneer Crossing to Bangerter Hwy
I-15 from University Ave to Pioneer Crossing
I-15 from US-6 to University Ave
Jul-16
Aug-16

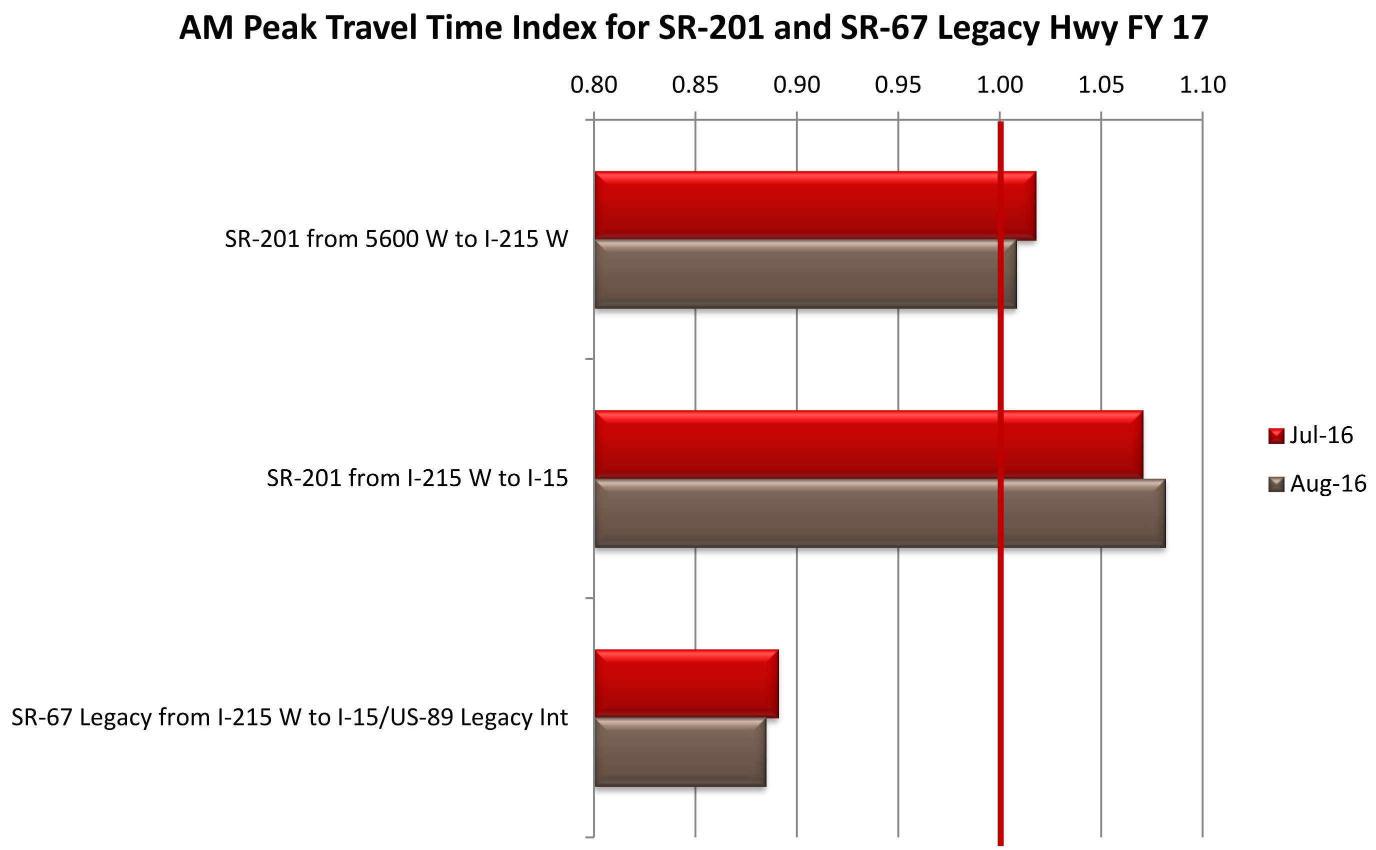

PM Peak Travel Time Index for I-15 FY 17
0.80
1.00
1.20
1.40
1.60
1.80
2.00
2.20
I-15 from 31st St Ogden to 2700 N Ogden
I-15 from Hill Field Rd to 31st St Ogden
I-15 from US-89/Legacy Int to Hill Field Rd
I-15 from I-215 N Int to US-89/Legacy Int
I-15 from 400 S SLC to I-215 N Int
I-15 from I-215 S Int to 400 S SLC
I-15 from Bangerter Hwy to I-215 South Int
I-15 from Pioneer Crossing to Bangerter Hwy
I-15 from University Ave to Pioneer Crossing
I-15 from US-6 to University Ave
Jul-16
Aug-16

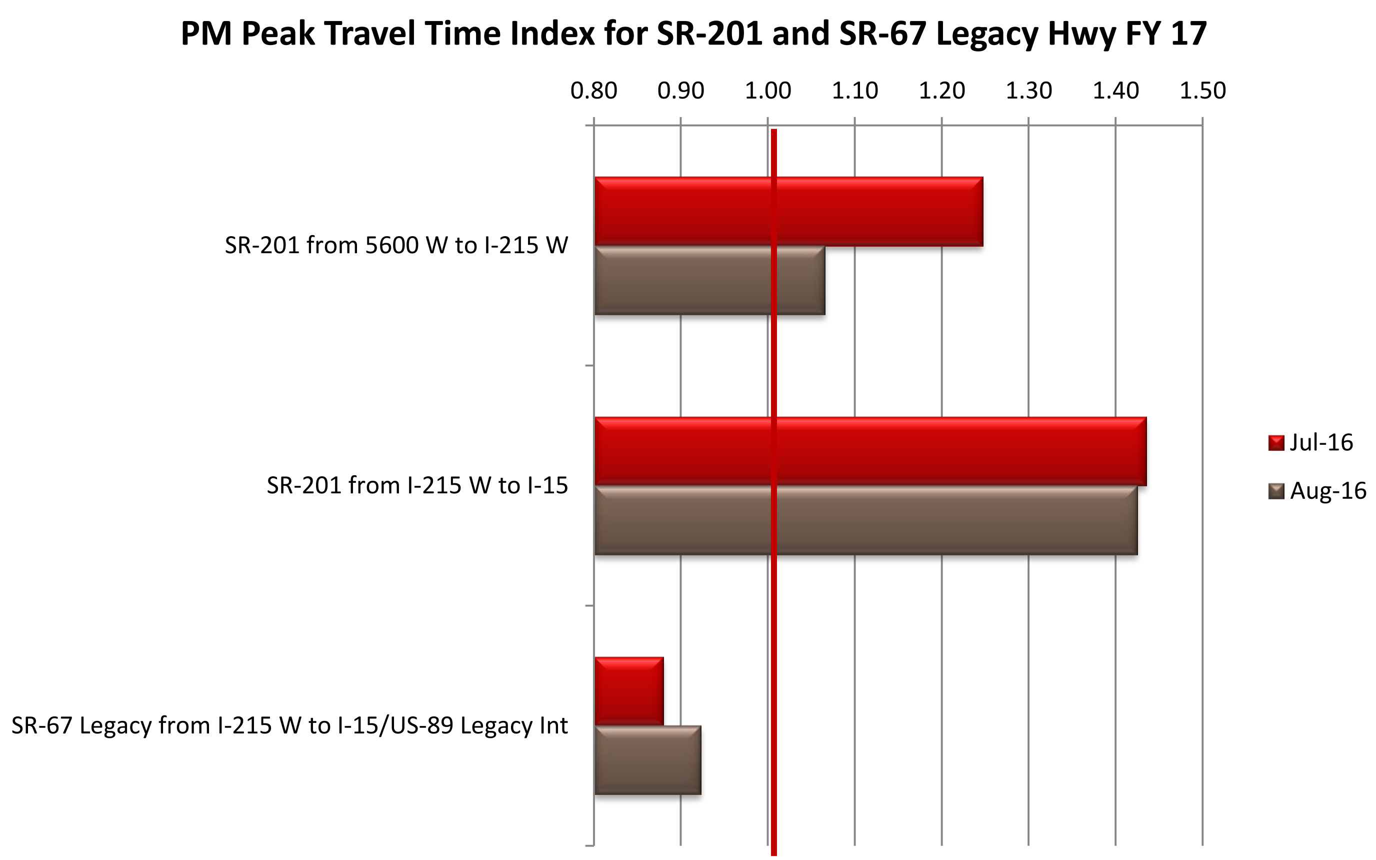

AM Peak Travel Time Index for I-80 FY 17
0.80
0.85
0.90
0.95
1.00
1.05
1.10
I-80 from I-215 E to US-40
I-80 from I-15 to I-215 E
I-80 from Bangerter Hwy/Airport to I-15
Jul-16
Aug-16


PM Peak Travel Time Index for I-80 FY 17
0.80
0.90
1.00
1.10
1.20
1.30
1.40
I-80 from I-215 E to US-40
I-80 from I-15 to I-215 E
I-80 from Bangerter Hwy/Airport to I-15
Jul-16
Aug-16

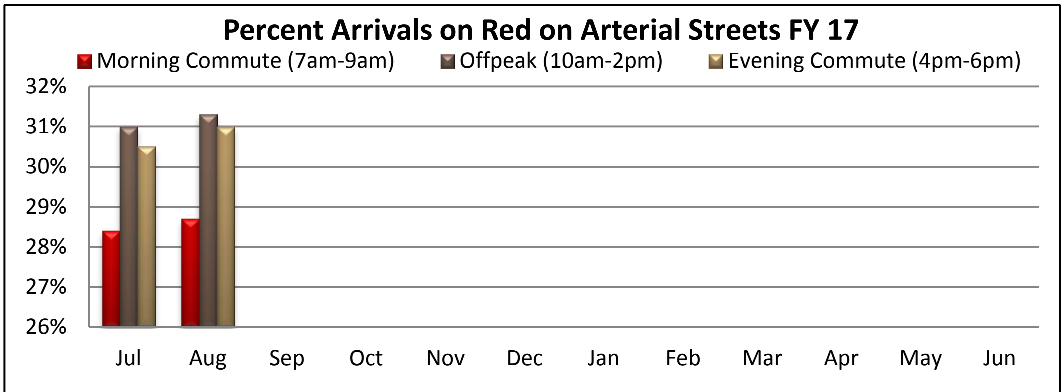

AM Peak Travel Time Index for I-215 FY 17
0.80
0.85
0.90
0.95
1.00
1.05
1.10
I-215 W from I-80 to I-15 N Int
I-215 W from I-15 to I-80
I-215 E from 6200 S to I-15
I-215 E from I-80 to 6200 S
Jul-16
Aug-16

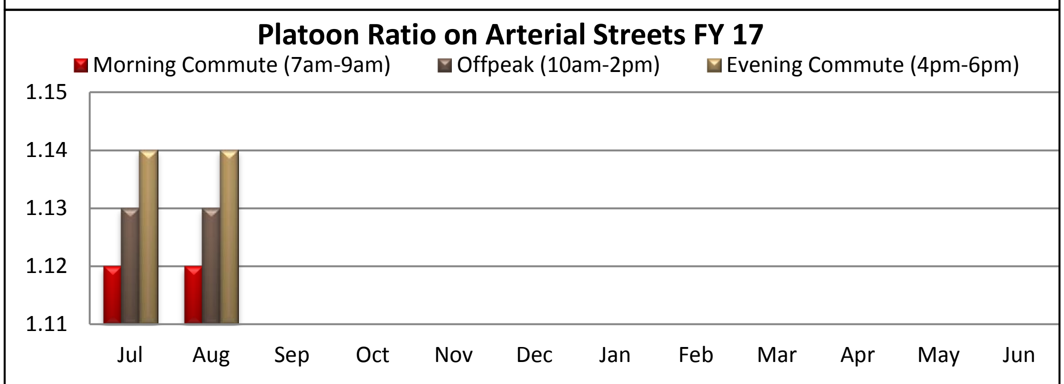

PM Peak Travel Time Index for I-215 FY 17
0.80
0.90
1.00
1.10
1.20
1.30
1.40
I-215 W from I-80 to I-15 N Int
I-215 W from I-15 to I-80
I-215 E from 6200 S to I-15
I-215 E from I-80 to 6200 S
Jul-16
Aug-16

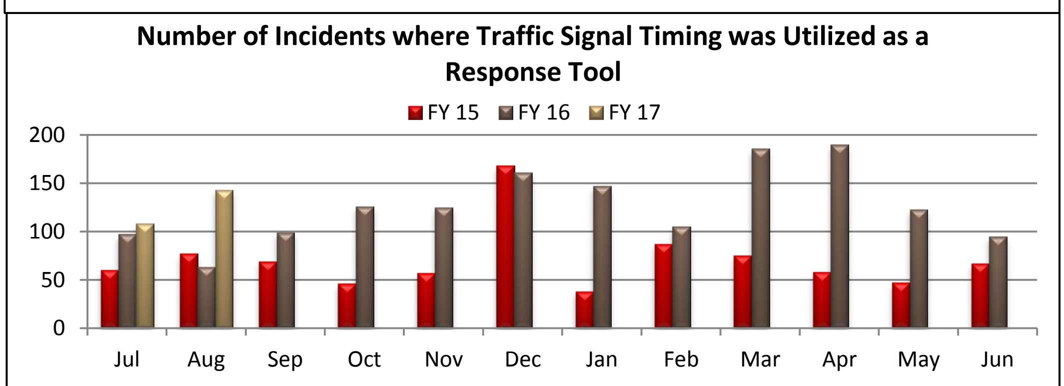

AM Peak Travel Time Index for SR-201 and SR-67 Legacy Hwy FY 17
0.80
0.85
0.90
0.95
1.00
1.05
1.10
SR-201 from 5600 W to I-215 W
SR-201 from I-215 W to I-15
SR-67 Legacy from I-215 W to I-15/US-89 Legacy Int
Jul-16
Aug-16

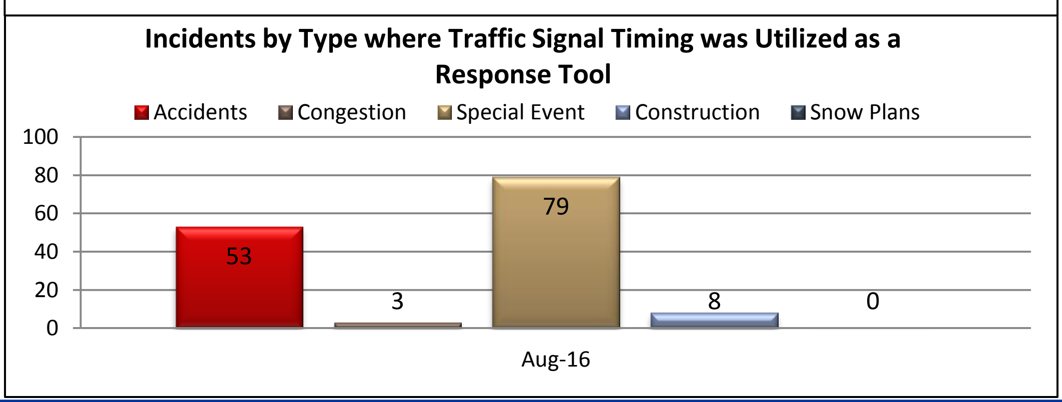

PM Peak Travel Time Index for SR-201 and SR-67 Legacy Hwy FY 17
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
SR-201 from 5600 W to I-215 W
SR-201 from I-215 W to I-15
SR-67 Legacy from I-215 W to I-15/US-89 Legacy Int
Jul-16
Aug-16

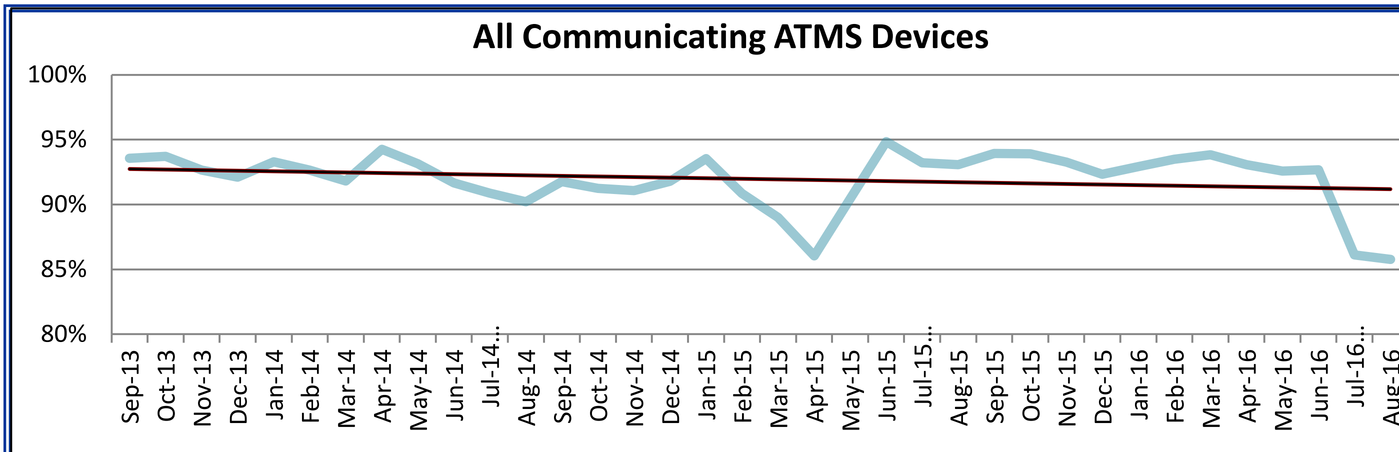
The percent arrival on red along the arterial statistics are generated automatically through the automated traffic signal performance measures, which show real-time and historical functionality at signalized intersections. The system automatically time-stamps when each vehicle arrives at the intersection and then compares the detection time-stamp if the phase was green or red. The percent arrival on red data is averaged over the 24 hours of the day and days in the month. . The lower charts shows the number of incidents where traffic signal timing was modified in order to help traffic flow around closed lanes, or to help relieve excessive congestion.

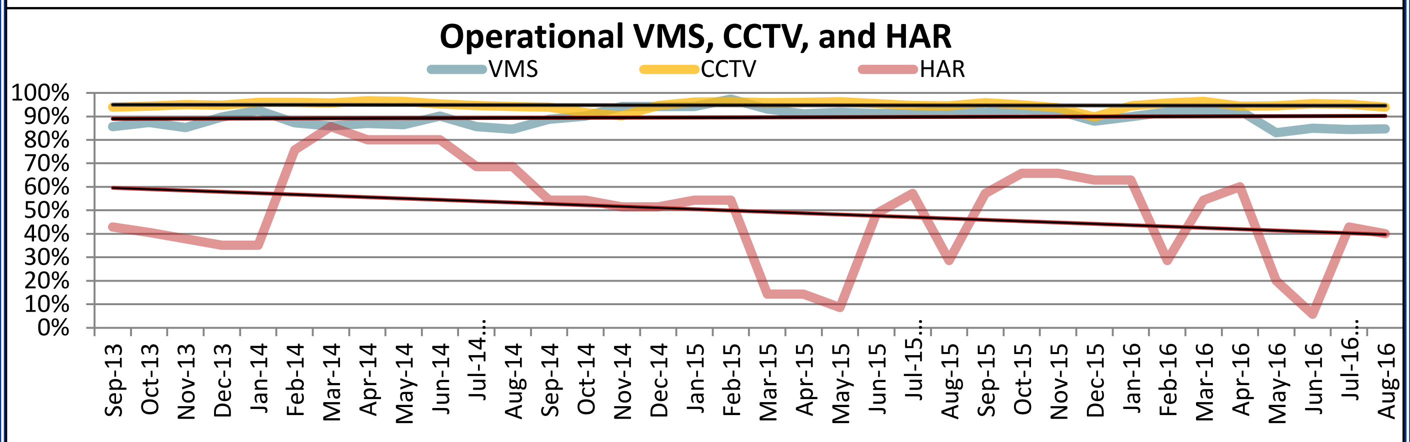


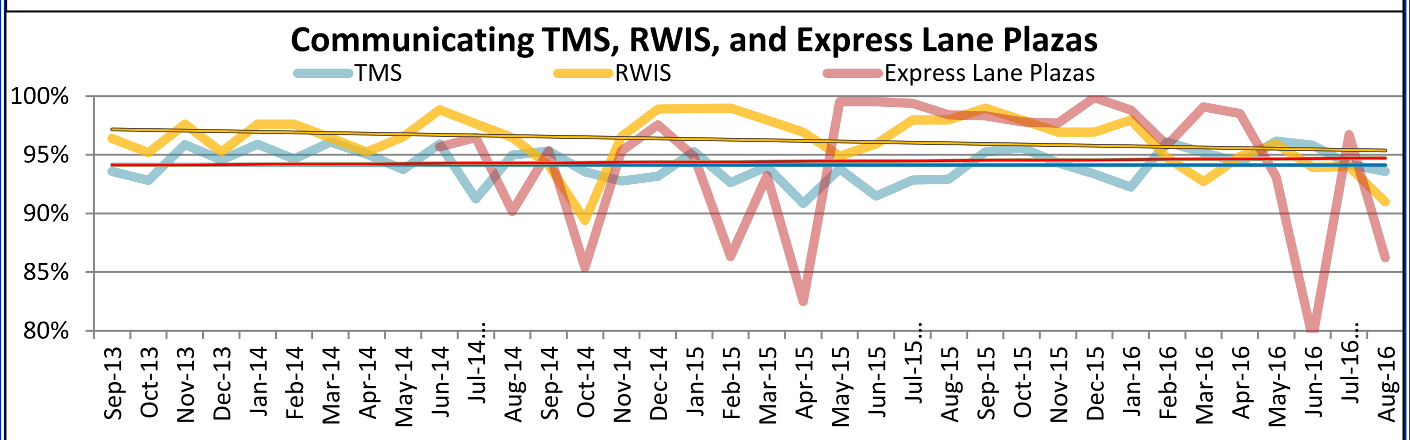


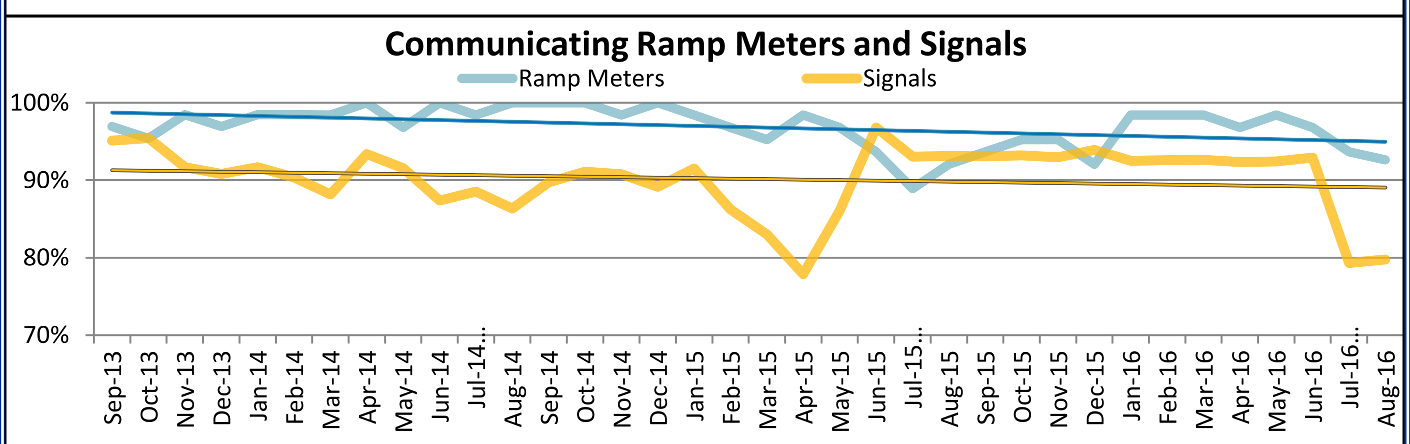




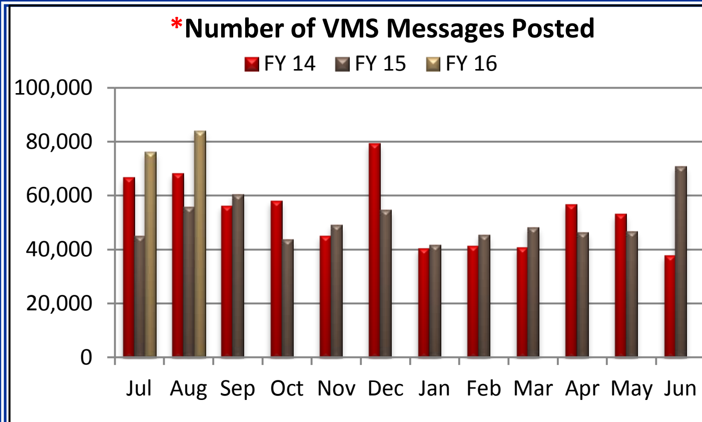

All Communicating ATMS Devices
100%
95%
90%
85%
80%
Sep-13
Oct-13
Nov-13
Dec-13
Jan-14
Feb-14
Mar-14
Apr-14
May-14
Jun-14
Jul-14...
Aug-14
Sep-14
Oct-14
Nov-14
Dec-14
Jan-15
Feb-15
Mar-15
Apr-15
May-15
Jun-15
Jul-15...
Aug-15
Sep-15
Oct-15
Nov-15
Dec-15
Jan-16
Feb-16
Mar-16
Apr-16
May-16
Jun-16
Jul-16...
Aug-16

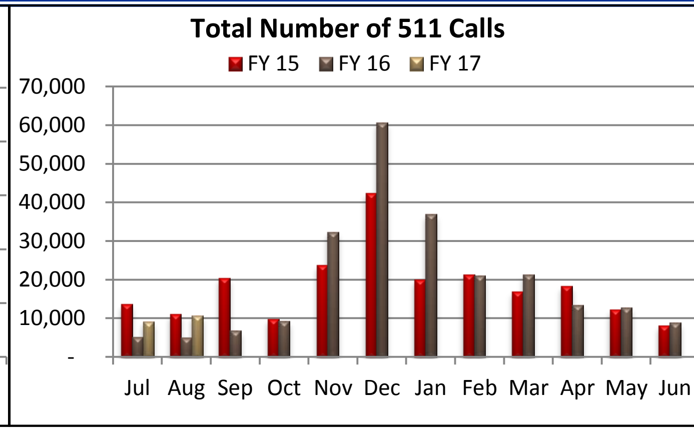

Operational VMS, CCTV, and HAR
VMS
CCTV
HAR
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

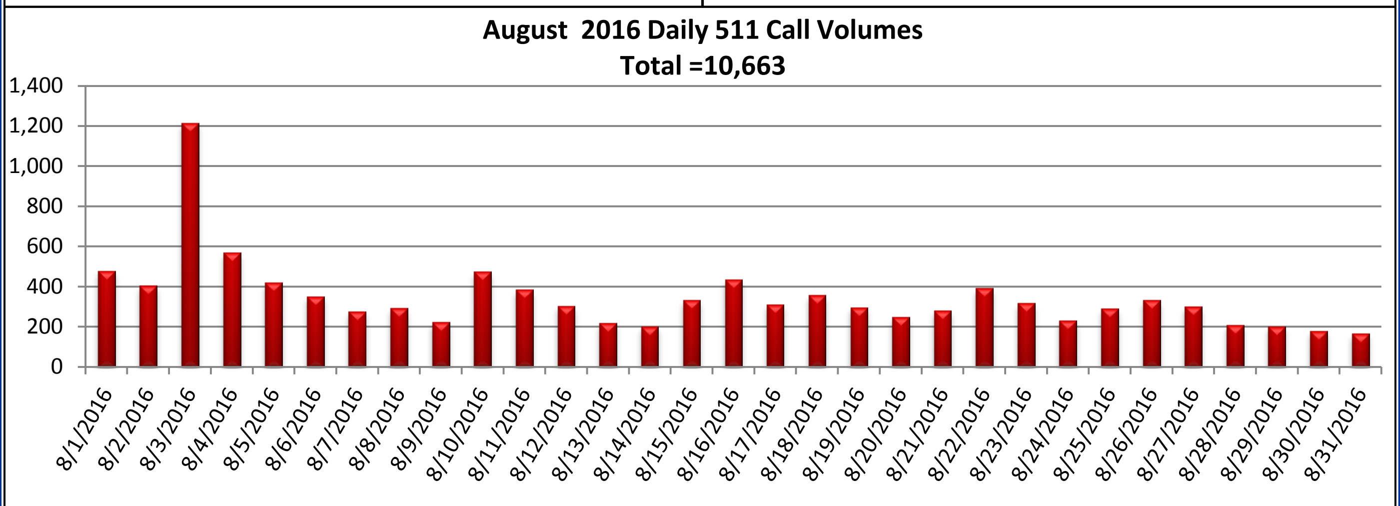

Communicating TMS, RWIS, and Express Lane Plazas
TMS
RWIS
Express Lane Plazas
100%
95%
90%
85%
80%

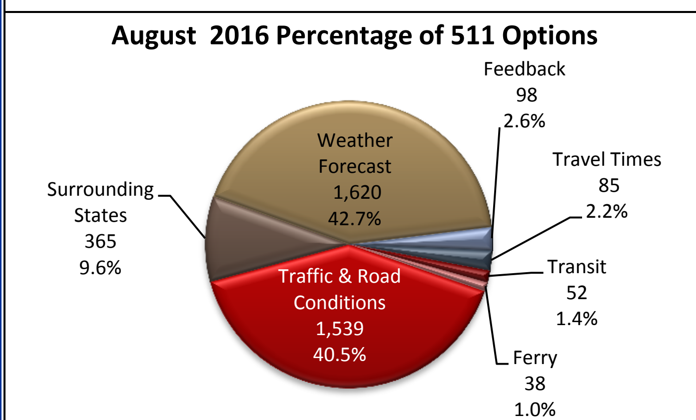

Communicating Ramp Meters and Signals
Ramp Meters
Signals
100%
90%
80%
70%

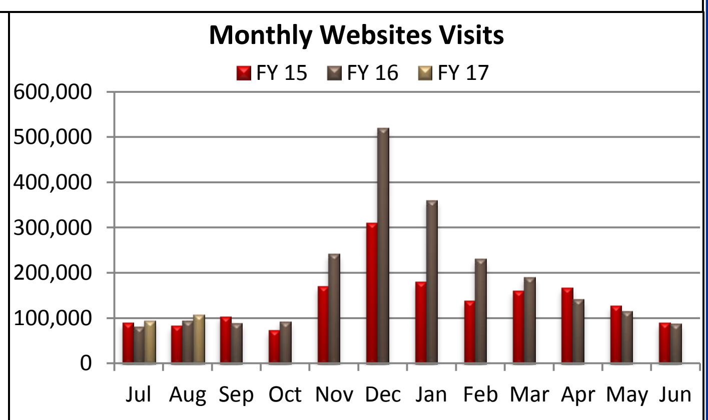
Traveler Information *Note – No VMS Data received Since August 2015

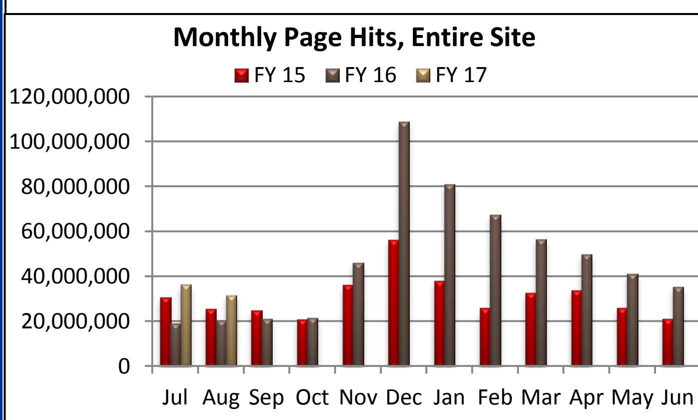


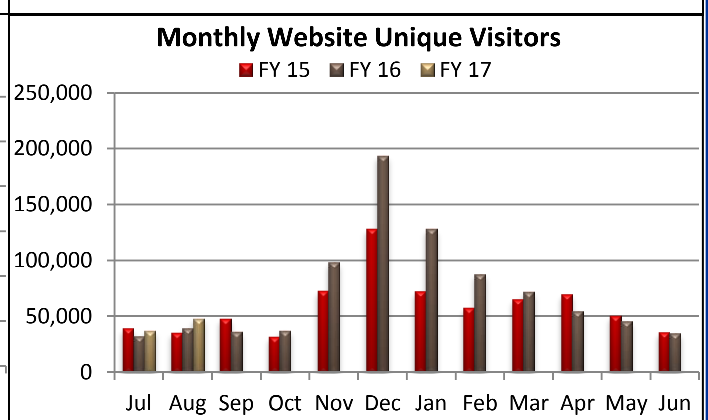




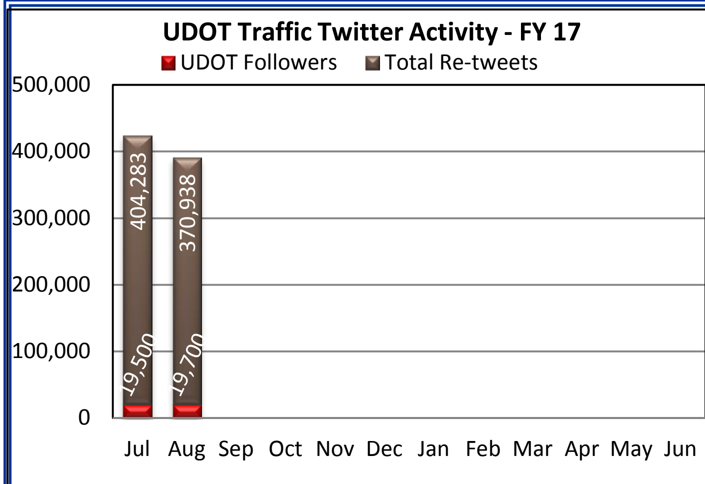


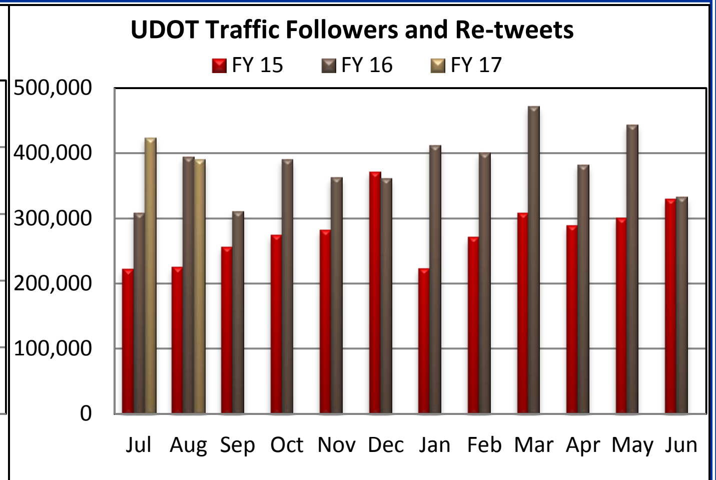


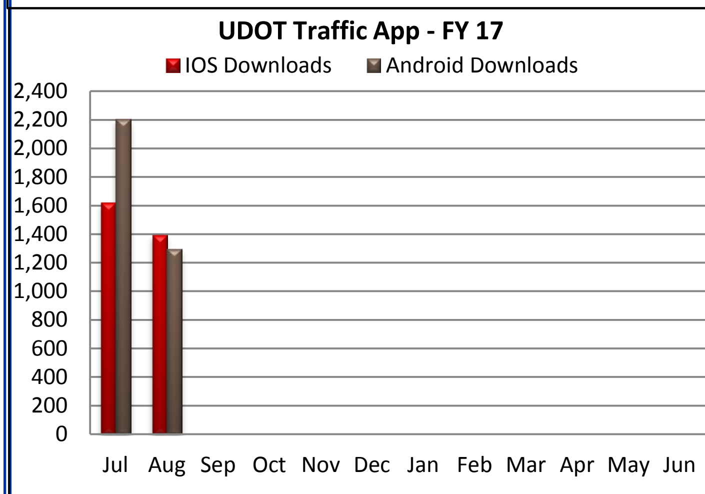


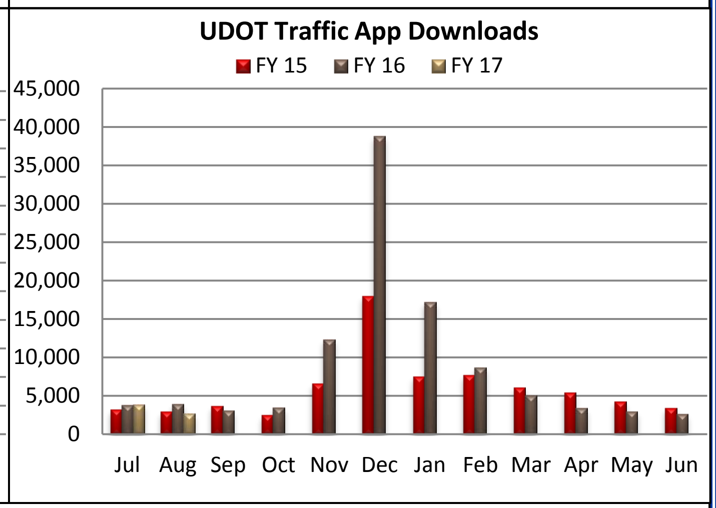


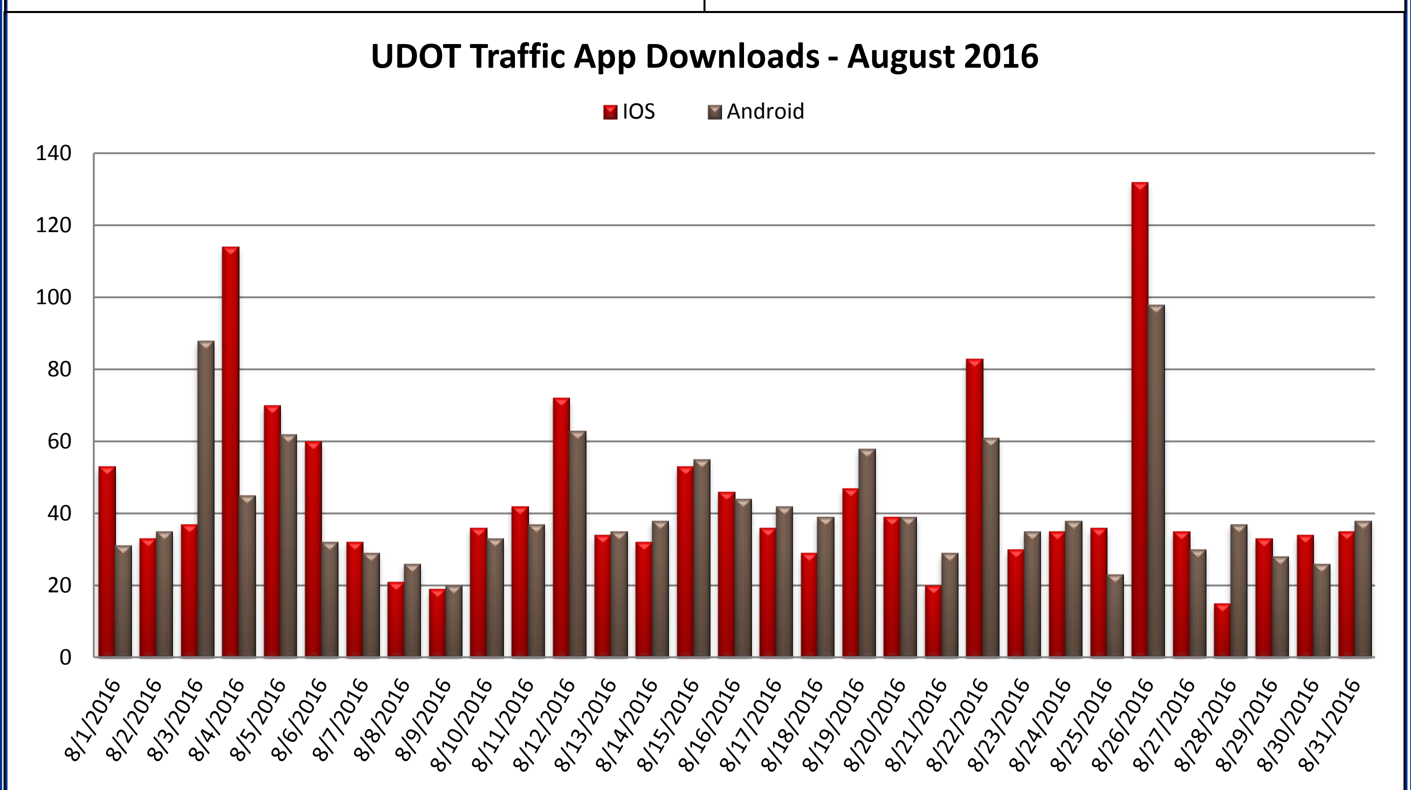
Social Media

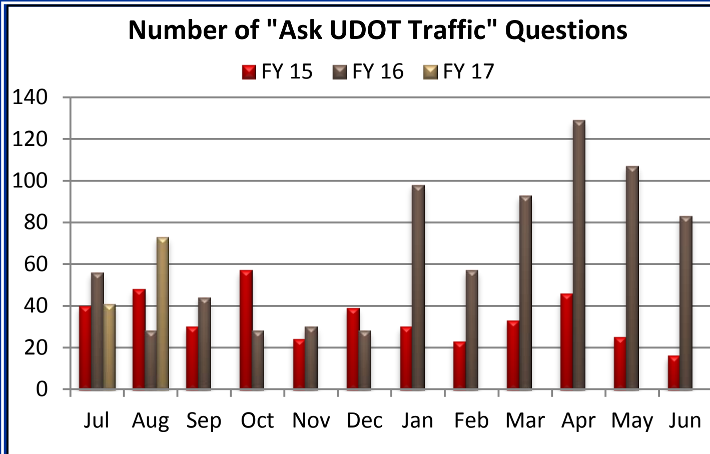


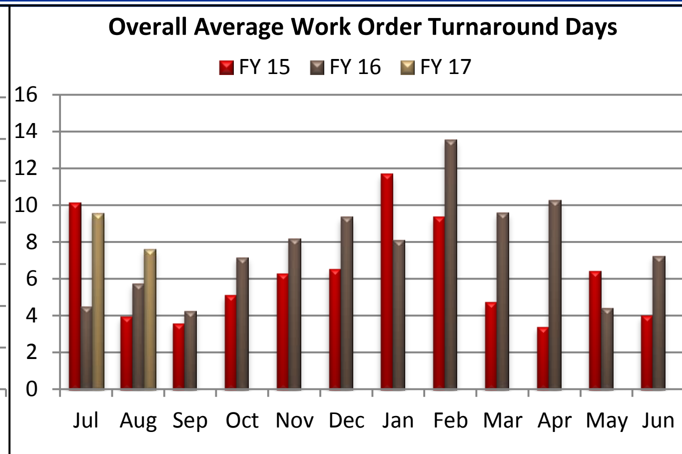


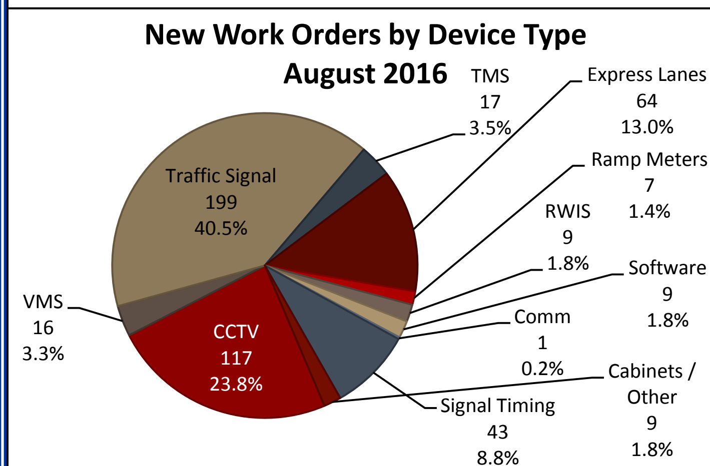


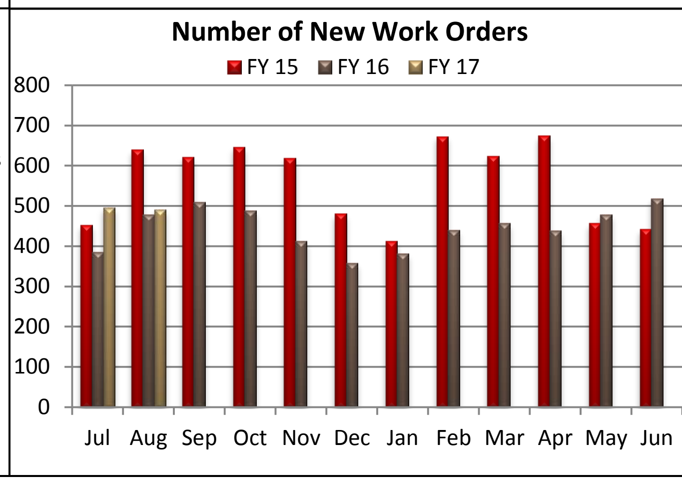


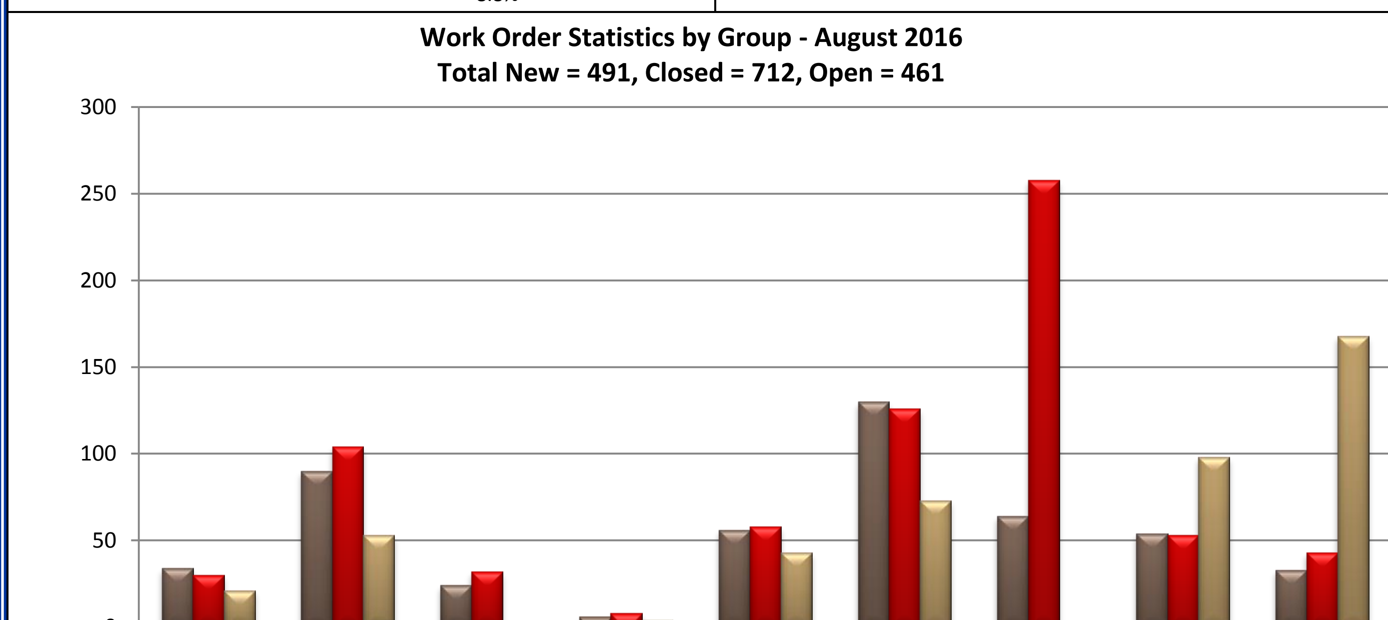












	R1 Signal Maintenance	R2 Signal Maintenance	R3 Signal Maintenance	R4 Signal Maintenance	Signal Timing	ATMS	Express Lanes	ISS	Other / Engineering / Contractor
New	34	90	24	6	56	130	64	54	33
Closed	30	104	32	8	58	126	258	53	43
Open	21	53	1	4	43	73	0	98	168

CONTROL ROOM

The Control Room staff assisted with the Tour of Utah bicycle race, the Outdoor Retailer Convention, and the Run Elevated Marathon. Assistance was also given to statewide roadwork with VMS and alerts while monitoring the Live Lane Closure site to improve road work response, coordination, and assisting the Wrong Way Driver Task Force.

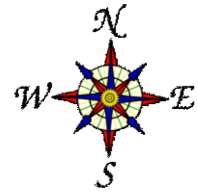
Karen Wilding was named the new Control Room Specialist. Her new responsibilities include working on special projects, quality control, operating procedure review, improving Control Room performance metrics. Liam Bradshaw replaced Karen as the Shift II supervisor. Congratulations to both fine employees.

The Control Room and DTS groups worked together on a new project that will maintain an electronic point of contact for all Control Room procedures, processes, phone contacts, training materials and other documentation. This project is scheduled to be fully functional by the end of November 2016.

The Control Room staff met with Region 4, discussing coordination between Control Room operations and region incident response; how to best support Zion National Park traffic; and established communication protocol.

TRAVELER INFORMATION

The Traveler Information staff supported UDOT Traffic Signals Group to prepare an equipment testing video; coordinated UDOT resources for Zion National Park high traffic events; and conducted in-person Citizen Reporter training for 25 new reporters.



WEATHER INFORMATION GROUP

The Weather Group had 106 overall UDOT weather interactions, 54 outgoing weather alerts, one National Weather Service collaboration, and no Road Weather Alerts.

Climatology

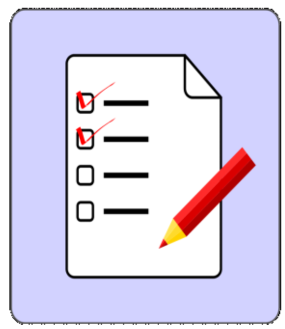
Monsoon weather continued to stay in Southern Utah where above normal precipitation occurred, but precipitation elsewhere remained well below normal. Temperatures statewide were largely about average, with Salt Lake City's average temperature 3.2 degrees above normal. For Salt Lake City, the summer of 2016 (June-August) was the second hottest on record behind 2013 and was the 11th driest.

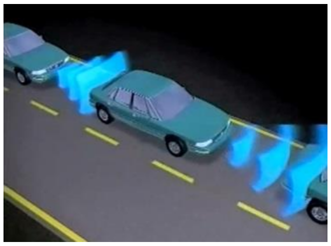
Weather Operations

Ford Motor Company inquired about traffic speeds during snowstorms and was directed to the Snow and Ice Performance website where weather and aggregate speed data from RWIS sites can be compared. WeatherCloud came to Salt Lake and installed mobile weather sensors on three Tesoro oil trucks to monitor conditions on I-80 and US-40 between Salt Lake and the Uinta Basin. The SR-14 Summit RWIS came online. Invasive road sensors that actively measure the salt brine freezing point on the road were installed at the Parley's Quarry and summit on I-15. Sensors were installed at a high crash-rate location on I-15 between Toquerville and Pintura to measure wind speed and rainfall for VMS messaging when there is standing water. The team deployed a portable RWIS just north of the Ebbs Canyon's dry creek bed to monitor debris flows from the Lower Ebbs Fire and a portable RWIS trailer was deployed at the Mountain View Corridor / 5400 South intersection to monitor winds so that the new vibration dampeners installed on the traffic signal arms can be evaluated.

TRAFFIC OPERATIONS AND REPORTING

- Involved with the Governor's Mobility Metric.
- SR-201/SR-36 analysis.
- MP 8 analysis.
- Delay, Reliability and Speed Report generation.
- Life of State Study.
- Five Interchanges Study in Region 1.
- Vehicle classification data with The Programming Group.
- Congestion Reporting.
- ITE committee meetings.
- Point Project timeline.
- Managed Motorways.
- TIRTL detection testing.
- 5400 South/4015 West analysis.
- Tooele IACR.
- Foothill/I-80 Interchange Study.
- 10600 South construction impacts.
- Region 3 future development meetings.
- Provo/Orem BRT.
- Logan Y intersection analysis.
- Vineyard Connector prioritization.
- US-6 study.
- Lehi Main Street/I-15 queue storage calculations.
- User Costs on multiple upcoming construction projects.
- US-40 construction impacts.
- Bangerter Highway interchanges.
- Asset Advisory Committee.
- Pleasant Grove Boulevard analysis.





ITS ASSET MANAGEMENT

ITS Asset Management team integrated 55 signals and updated another 50 signals. Integrated about 17 new freeway cameras while removing ten from service. Six surface street CCTVs were integrated and two RWIS CCTV's were removed for a net gain of 11 CCTV's to the system. Five ramp meters, 28 TMS, and four freeway and surface street VMS were integrated. The team continued to participate in the AIMS asset management update meetings and monitoring CCTV images available to our partners.

TRAFFIC SIGNAL OPERATIONS

- **Region 1** retimed several corridors in Bountiful, turned on the I-15 SPUI at Hill Field Road, activated the new signal at 2600 South / SR-165 in Nibley, and installed new pedestrian activated overhead flashers at SR-82 / 1500 South in Garland.

- **Region 2** installed several new school crossing guard key switches to improve safety for crossing guards and school children.

- **Region 3** retimed University Parkway and 800 North in Orem, assisted BYU in setting up two new traffic signals and detection, assisted Orem City turning on the new traffic signal at 1200 W & 800 S; and installed special event signal plans for the first week of school at UVU & BYU.

- **Region 4** activated and integrated a new traffic signal into Moab's adaptive traffic signal system; assisted St. George City with programing and testing the new signal database at Horseman Park Drive and River Road; and installed a new school zone at SR-153 and 600 East in Beaver.

ATMS MAINTENANCE

Field Team

The Field Team made several visits to various VMS sites to get them up and running before the Labor Day weekend. Locations visited were Cedar City, Hanksville, Beaver, Lake Powell and Logan. A joint effort was made with the Lab Team to complete LFOT located on I-70 @ Salina. LOFTs were also performed in Spanish Fork at Main Street @ 300 S, Main Street @ 1000 N, and US-6 @ Center Street. Electrical inspection plus full operation tests were made on all associated TMS equipment.

Total work orders closed for the month of August was 100.

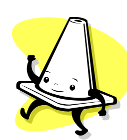
Lab Team

Inclusive of Digi Terminal Servers, Traffic Signal Controllers, 2070 Controllers, Wireless Radio, Wavetronix Radar and CCTV a total of 19 devices were tested/repaired. One traffic signal cabinet was tested and burned in for Region 2's spare cabinets. Released one traffic signal cabinet to KV Electric for I-215 & 4700 S and one for CVE at South Jordon Pkwy & MVC. The team performed 34 LOFTs for the Point Project and preventative maintenance on 155 TMS locations. Provided assistance to the Express Lanes by installing three network controlled power relays and made up eight harnesses for those relays, the team also rebooted five controllers and performed a system drive.

There are 18 open work orders; 14 of which are on hold for loop replacements. The Electronics Lab closed 22 work orders during the month of August.

Express Lanes Team

The Express Lane Team closed 277 work orders, performed PMs on 15 cabinets and the scheduled weekly system drives. The team also repaired and programmed 22 lane controllers and replaced 10 lane controllers, replaced two Sensys Pucks and recalibrated two. The team rebooted 13 lane controllers and one reader. Six VTMS required hard reboots. Eight lane PMs were performed which required full lane closures. Use of the lane closures allowed the team to replace the N-type connectors between a reader and the antennas. The team also installed six Ethernet relays. David Putnam and Mike Xiras from the Lab Group assisted whenever extra manpower was needed.



Region One

Statewide Signal Interconnect: PS&E has taken place, advertisement is eminent.

US-60 and 2700E: In design.

SR-232 Hillfield Rd. Interchange: Under construction.

30th Street and Harrison: Under construction.

650 N. I-15 Clearfield: Under construction.

I-15; SR-30 to the Idaho State line: This project may be part of a partnership with a telecom.

Layton Interchange: This project is in design.

32nd Street and US-89: Construction complete, integration in process.

Antelope and Main: Integration in process.

Sardine Canyon US-89 from Brigham to Wellsville: In design.

US-89; Antelope Drive Extension: Construction complete, integration in process.

Logan CCTV's: This project has been completed.

Region Two

- **Managed Motorway Detection – TIRTL Device Testing:** We have concluded the TIRTL detector test and have done some basic analysis of the count data and compared it against video and other NID technology. We will be finalizing our report of the TIRTL test next month.

- **Salt Lake Valley Traffic Signal Interconnect:** Several new signals in Salt Lake City are now online now that the integration contract is in place. We will be putting in cell modem connections in the U of U campus at two critical locations for football traffic management.

- **I-15 Point Project:** The main fiber backbone was spliced over to its new strands and the entire new ATMS system was switched over to the new system overnight. Most devices were integrated prior to the cut over and were ready to communicate on the new system. A few devices needed troubleshooting, but overall, the cut over went well and the outages were minimal. There was great coordination between the Design-Build team, sub-contractors, and various users and support groups at UDOT to plan for the optimal outcome.

Region 3

- **SR-92 CCTV/Hybrid VMS (12641):** Replaced failed wireless antenna electronics. Started 30 day burn-in.
- **Region 3 traffic signal connections (12774):** SR-198 @ Woodland Hills + CCTV, SR-198 @ 400 North, and SR-198 @ Main St + CCTV in Salem via wireless radio connection. Continued 30 day burn-in.
- **US-40 CCTV/Signal connections (12805):** STRATA installed connection electronics to eight signals in the basin area. Due to issues with the STRATA links, hub switch installation was re-scheduled. Network connection complete. CCTV's LFOT's pending.
- **US-189; State Park to Rock Cut passing Lanes (11415):** Project under construction. Power disconnect installation change order identified.
- **Spanish Fork; SR-156; 300 South to M.P. 2 (9976):** Project under construction. 400 North CCTV failed LFOT. Needs repair.
- **Provo; SR-256; 800 East to University Ave BRT (10266):** ATMS design of micro fiber and two CCTV's ongoing. Project under construction.
- **Spanish Fork; Canyon Rd @ 2550 E Signal (10960):** Project under construction.
- **Provo; US-89 (300 S); 100 East to 700 East (10137):** Project under construction. Temporary fiber was dug up. Repair is needed.
- **Utah County Signal Interconnect (13244):** Project in advertisement.
- **Eagle Mountain; SR-73 @ Sunset Dr. (13217):** Project complete.
- **I-15 Fiber; Payson to Santaquin (14149):** Design contract under negotiation.
- **Pleasant Grove; US-89 @ 200/220 South (14683):** Project under construction.
- **Highland; SR-92 @ 6400 West Signal (14595):** Project under construction. Started 30 day burn-in.
- **American Fork; US-89 @ Main St./200 East (13061):** Project in design.
- **Payson; 1400 South State St (SR-198) Signal/CCTV (14573):** Project in design.
- **Highland; SR-129 @ 1100 North Signal/CCTV (14955):** Held Project kick-off.

Region 4

- **St. George:** This project is complete, except for some city and UDOT fiber coordination. Pinetop is in the process of integration.
- **Salina VMS and Fiber:** Under construction. Punch list items are being mitigated.
- **Fiber upgrade for US-6, Helper and Price Signal Integration:** This project could not be awarded due to contract limitations. We are looking into other ways to advertise.
- **I-70 in Richfield:** In design.
- **Cedar City Fiber:** Under construction.
- **Price, Helper fiber and Interconnect:** This project has been completed.

ITS Standards and Specifications:

The first half of the 2017 ATMS Standard revisions were accepted during the August 25th Standards Committee meeting.

Time was dedicated to reviewing and providing comments to the other standards groups with a large number of revised standards to review.

Work continued revising the Freeway Management portion of the AT Series Standard Drawings and specifications. These were sent out to Pinetop Engineering for additional comment and suggestions and was returned with useful commentary.

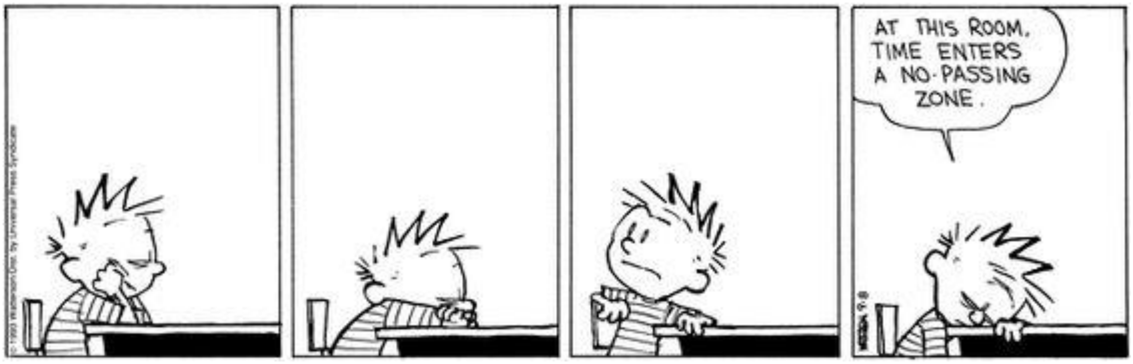
Work recommenced on the RWIS – ESS Standards. Due to postponing the Solar Powered ITS site standards, the solar panel support structure was revised and for the 2017 RWIS Photo Voltaic panel system.
Work to revise the Polymer Concrete Junction Box Drawing AT 7A and Spec. 13554 was re-started.

Procurement:
The Adaptive Micro Systems (AMS) contract will expire this month. This is a sole source contract required to provide replacement parts for the, retrofitted, Mark IV VMS. John Hansen represents AMS and will stop by the TOC in September to discuss changes and upgrades taking place in the retrofit industry and with AMS.

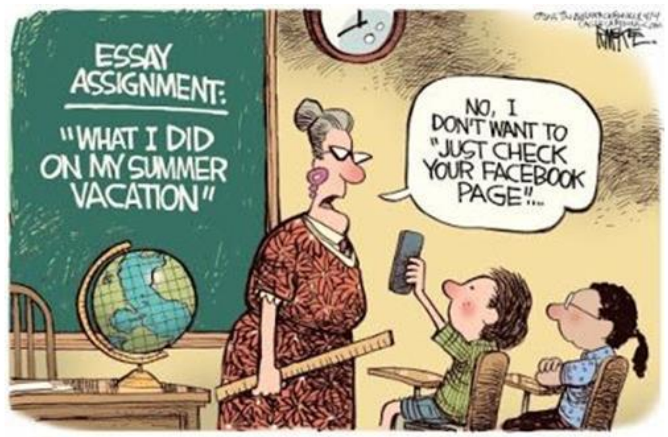
The ITE Journal article featuring Automated Traffic Signal Performance Measures that mentions a few of our own that are involved in this technology. Very exciting.

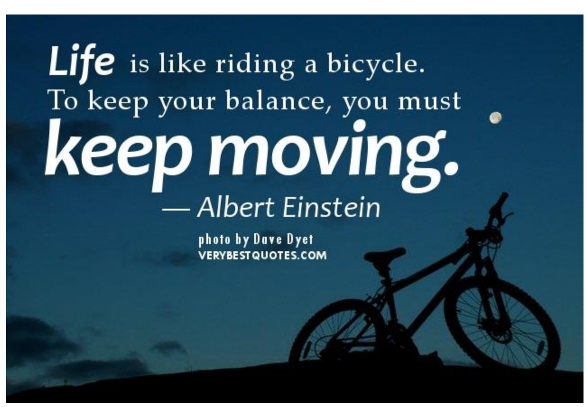
The link for the entire magazine is:
https://drive.google.com/a/utah.gov/file/d/0B4f0DsaXV-GeLWhXa19Ha0h5N00/view?usp=drive_web

Check out page 27


AT THIS ROOM, TIME ENTERS A NO-PASSING ZONE.


Sigh . . . there goes another summer, Snoopy!


ESSAY ASSIGNMENT:
"WHAT I DID ON MY SUMMER VACATION"
NO, I DON'T WANT TO "JUST CHECK YOUR FACEBOOK PAGE"!...


Life is like riding a bicycle.
To keep your balance, you must
keep moving.
— Albert Einstein
photo by Dave Dyet
VERYBESTQUOTES.COM

Acronyms

CCTV	Closed Circuit Television	DPS	Department of Public Safety
EIS	Emergency Information System	HAR	Highway Advisory Radio
I2TMS	Integrated Interagency Traffic Management System		
ITS	Intelligent Transportation System	LFOT	Local Field Operations Test
MIC	Manager in Charge	MOT	Maintenance of Traffic
RWIS	Road-Weather Information System	TAC	Technical Advisory Committee
TMD	Traffic Management Division	TMS	Traffic Monitoring Station
TOC	Traffic Operations Center	VMS	Variable Message Sign

UDOT

Keeping Utah Moving

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AUGUST 2016
volume 86 • number 8

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Implementation of Automated Traffic Signal Performance Measures

By Christopher M. Day, Ph.D., Mark Taylor, P.E., PTOE, Jamie Mackey, P.E., PTOE, Rob Clayton, P.E., PTOE, Shital K. Patel, P.E., Gang Xie, P.E., Howell Li, James R. Sturdevant, P.E., and Darcy Bullock, P.E.

Over the last few decades traffic signal systems have evolved from rigid, fixed-time electromechanical systems to a distributed computing model with sophisticated detection and communication infrastructure. Although modern signal systems are relatively robust, operating continuously for years under all weather conditions, there is a tendency for operational inefficiencies to accumulate over time, as individual components such as detectors fail, or traffic conditions evolve beyond the parameters that the signal control was designed to accommodate. For a number of years, the engineering community has acknowledged opportunities for improvement, such as retiming or investing in new equipment.[1] However, historically, it has been very difficult to comprehensively evaluate changes in signal operations because the cost of data collection constrained the temporal and spatial extent of study.

Over the past decade, traffic engineers in several states have worked with a consortium of vendors and university researchers to develop a common means of collecting and communicating detailed data based on events that are measurable by a signal controller, such as changes in detector presence or signal phase and overlap states. These events are captured at the smallest time resolution of a signal controller (currently 0.1 second). Using this "high-resolution data," researchers developed a series of signal performance measures (SPMs) that can provide insights into signal systems operation. These have been demonstrated in numerous applications including arterial progression, capacity allocation, queuing and oversaturation, pedestrian performance, railroad preemption, and diamond interchange operations.[2,3,4,5,6,7]

In 2012, eleven state departments of transportation (DOTs) and the City of Chicago joined together in a Pooled Fund Study (TPF-5(258)) to further develop SPMs, and in 2013 SPMs were selected as an American Association of State Highway and Transportation Officials (AASHTO) Innovation Initiative technology. An *ITE Journal* article introducing SPMs was published in 2014, accompanied by a webinar series.[8] Two monographs were published on SPMs, including basic SPM definitions and a series of example use cases for implementation.[9,10] The Pooled Fund Study culminated in 2016 with a two-day workshop in Salt Lake City (Figure 1) that attracted 170 attendees from across the country. Figure 2 shows a map of the distribution of workshop attendees across the United States and Canada. Participants from agencies and the private sector expressed strong support for accelerating the deployment of SPMs. This article gives an update on the current state of SPM implementation and how interested agencies, consultants, and researchers can get involved in this effort. Three examples of recently developed metrics are presented. Finally, the future of SPM research, development, and implementation is discussed.

DARCY BULLOCK

Figure 1. Attendees at the Salt Lake City Signal Performance Measures Workshop, January 26–27, 2016.

High-resolution Data

The basic data elements for measuring performance are in all modern microprocessor-based controllers: the signal output states and the presence of traffic as measured by detectors. Such data have been called "high-resolution data" because they represent controller states at the smallest possible time resolution, in comparison with aggregate measures accrued over 1-minute or longer intervals. In

Figure 2. Map showing the locations of Salt Lake City Signal Performance Measures Workshop participants.

the past, these data were discarded because there was no way to store them or communicate them back to the office. Some advanced control systems used similar types of data for making responsive and adaptive decisions, but the data were abstracted to internal performance measures that were difficult to access for detailed or longitudinal analysis and typically not interoperable between different vendors' equipment.

High-resolution data overcome the problem of interoperability by using the same core set of events for data logging, which can be used by any vendor.[11] At the time of writing, at least six controller vendors have adopted the event enumerations. Technology advances have mitigated issues of data storage and communication. The number of events is driven by the amount of traffic and the number of detectors. A low-volume intersection (e.g., 10,000 vehicles per day) generates under 100,000 events per day, requiring under 400 kilobytes (KB) per day to store. In contrast, a high-volume intersection (80,000 vehicles per day) can generate up to 450,000 events per day, requiring up to 1,800 KB to store. Data compression can reduce the required bandwidth considerably. These are relatively small amounts of data in comparison to, for example, smartphones, which use about 2 gigabytes (GB) per month on average.

Table 1 shows a listing of the number of intersections from agencies that presented at the 2016 SPM workshop in Salt Lake City and the controller types they use to collect high-resolution data. Among this group of state and local agencies, there are more than 3,100 intersections with high-resolution data that are actively used to generate SPMs, a number that is approaching 1 percent of the estimated number of signalized intersections in the United States. However, the controller models listed in Table 1 are in much wider distribution than among these agencies, and additional vendors have implemented data collection in their controllers, making this number a very low estimate of the distribution of high-resolution data. In addition, there are probably many intersections that currently possess the ability to log high-resolution data, but the feature has not yet been enabled.

Table 1. Number of traffic signals by controller vendor with high-resolution data collection operated by presenters at the Salt Lake City SPM Workshop.

Vendor	Controller(s)	Number of Traffic Signals	Jurisdictions
Econolite	ASC/3, Cobalt, 2070 1B, 2070 1C	2157	Utah DOT, Indiana DOT, Minnesota DOT, Wisconsin DOT, Overland Park, KS, USA
Intelight	X1, X2, X3	422	Utah DOT, Georgia DOT
Siemens	m50 Linux, m60	68	Indiana DOT, Virginia DOT
Peek	ATC	15	Indiana DOT
Trafficware	980 ATC	513	Las Vegas NV, Seminole County, FL, USA
McCain	ATC eX	5	Utah DOT, Florida DOT
	Total	**3180**	

Example Performance Measure Implementations

Utah Department of Transportation

The Utah Department of Transportation (UDOT) was introduced to SPMs in 2012 by Purdue University and the Indiana Department of Transportation (INDOT), and soon after it developed software to calculate and display the metrics. Currently 1,700 signals (86 percent) statewide have data in the system. SPMs are now an integral part of signal operations and system management in Utah. UDOT has had great success using the Phase Termination Chart, Split Monitor, Purdue Coordination Diagram, and other metrics to identify and troubleshoot issues, confirm and address complaints, and optimize signal operations. These metrics were discussed in more detail in a previous *ITE Journal* article. The UDOT signal performance measure website is available at: http://udottraffic.utah.gov/signalperformancemetrics.

UDOT recently implemented a new metric, Purdue Split Failure, which provides another detailed view of signal operations. The metric relies on existing stop bar presence detection either by lane group or lane-by-lane. The metric calculates the percent of time stop bar detectors are occupied during the green phase and then during the first five seconds of red. These numbers are called the Green Occupancy Ratio (GOR) and Red Occupancy Ratio (ROR). If the occupancy ratios are both more than 80 percent, that phase is considered a split failure in that cycle—a threshold based on previous field studies.[12] When multiple consecutive split failures occur, it can indicate that queued vehicles are not being served in one cycle.

Figure 3 shows an example of the Purdue Split Failure metric as it is visualized in the UDOT SPM website. The chart shows a typical day for the southbound through movement at a particular intersection. During the AM peak, the southbound approach has a low GOR, indicating that there is unused green time. Between 11 a.m. and 4 p.m., GOR is higher, but ROR is generally low, which suggests queues usually clear each cycle. In the PM peak, both GOR and ROR are high, which means the southbound approach is likely over capacity.

UDOT engineers have already made extensive use of this new metric in the short time that it has been implemented. Engineers were initially pleased to discover that there were *not* widespread split failures in most of the coordinated systems, outside of the peak periods. This indicates that obvious split failures tend to

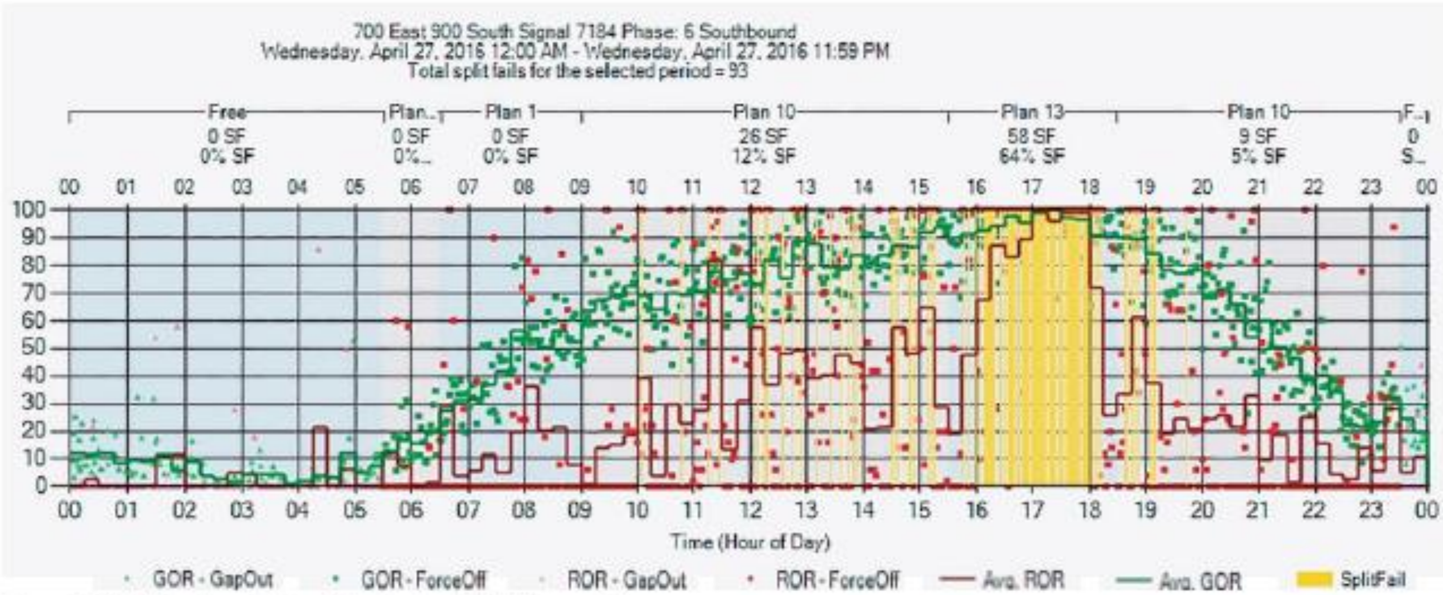

Figure 3. UDOT implementation of the Purdue Split Failure metric.

be corrected in response to public complaints, through retiming projects and use of other metrics within SPMs. However, there were a surprising number of split failures occurring during free operation. In general, maximum green times are not as carefully designed as coordinated splits, because it is assumed that movements will gap out after queues are cleared. However, at high volumes, free signals sometimes run excessively high cycle lengths, and may not give enough time to certain movements. The Purdue Split Failure metric makes it apparent when there is a need to adjust time of day patterns to use alternate maximum green times.

SPMs are also useful for validating complaint calls by enabling engineers to pinpoint the time of day and compare performance of a problem movement with others at the same intersection. The Purdue Split Failure metric has proven unexpectedly useful for diagnostic uses in detector configuration and controller programming. For example, locations where passage time is too short or where detectors are incorrectly configured for pulse output rather than presence output are evident from unusually low occupancy values. Finally, SPMs bring the convenience of being able to assess problems at any time of day without requiring staff to work routinely outside of normal business hours.

Las Vegas, NV, USA

The Las Vegas Freeway and Arterial System of Transportation (FAST) recently implemented a program to display SPMs, based on the UDOT source code, with several new enhancements and new metrics (http://challenger.nvfast.org/spm/). Figure 4 (a & b) shows examples of these.

One feature that FAST developed for its SPM website is the time-space diagram (TSD), as shown in Figure 4a. This tool displays signal progression for multiple directions along a corridor, showing the actual signal timing obtained from the high-resolution data. It is possible to compare and contrast the real timing with the programmed timing, and to overlay GPS data trajectories, as demonstrated in Figure 4a. Detector data is not required to produce this graphic.

Another new metric is the Pedestrian Actuation Plot, which is similar to the Purdue Coordination Diagram, except that pedestrian actuations are visualized instead of vehicle detector

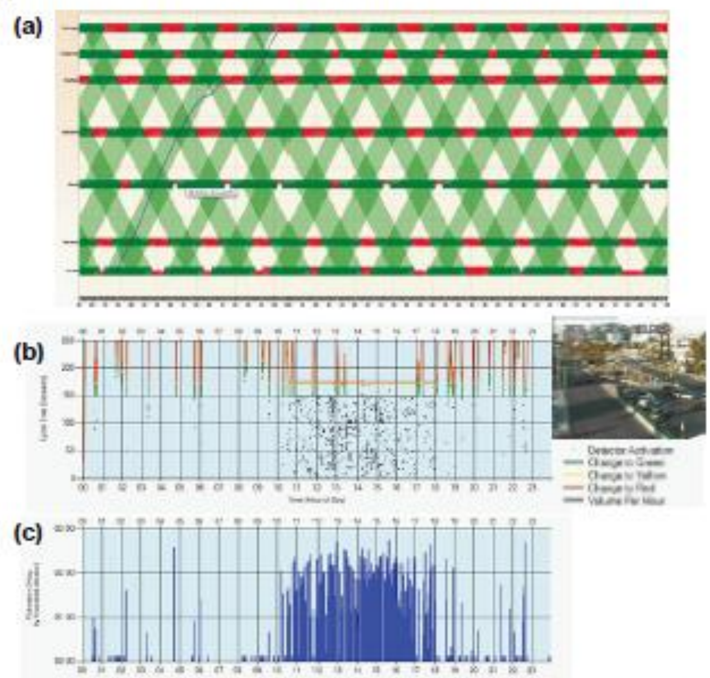

Figure 4. Performance measure graphics implemented by Las Vegas FAST.

actuations. Las Vegas has a large number of pedestrians because of tourist traffic. Figure 4b shows an example from a pedestrian crossing near the "Welcome to Fabulous Las Vegas" sign, which displays the number of pedestrian button actuations on New Years' Day, 2016. Each dot represents an occurrence where the button was pushed, relative to the signal state at that time in the cycle. Figure 4c shows the amount of wait time for the first pedestrian until the start of the Walk indication.

Although pedestrian button actuations do not give the exact number of pedestrians, knowing the frequency of calls and amount of pedestrian delay can assist the engineer to choose appropriate strategies to create a signal timing plan that is safer and more friendly to pedestrians and efficient for vehicle traffic. For example, at a pedestrian crosswalk, if the actuations are infrequent, a shorter time may be allocated for the vehicle traffic, whereas if there are many actuations a longer cycle length or vehicle phase max time could be used.

Indiana Department of Transportation

INDOT began exploring high-resolution data in the 1990s when it began testing new vehicle detection technologies. To compare detection technologies, it was necessary to obtain detector on/off times at a fine time resolution, as well as the signal states. During that research, it was found that the detector and phase state data could also enable the quality of progression and capacity allocation to be evaluated in detail.[13] After the initial deployments of controllers with embedded data loggers in 2006, INDOT began growing its system through anticipated upgrades. As the older generation of controllers reached the end of their lives, they were replaced with models that included data loggers. Beginning in 2010, data collection processes were managed on servers that handled the statewide ITS system.

The split failures in the Purdue Split Failure metric (Figure 3) can be aggregated to a count of split failures over a given time period, which is useful for viewing performance at a corridor or system level, enabling engineers to quickly identify problem movements across hundreds of intersections and movements.[14] Figure 5 shows an example for US 31 in Greenwood, Indiana. This is an 11-intersection corridor on the south side of the Indianapolis metro area. On weekdays, the corridor serves typical inbound/outbound peak flows of traffic into and out of Indianapolis. The north end of the corridor experiences heavy traffic on weekends due to shopping and other commercial activities concentrated in that area.

Figure 5 shows split failures by movement, averaged over 27 Saturdays from January 1 through June 30, 2016, for the 11:00 a.m. to 7:00 p.m. time period. Large numbers of split failures are evident for the three northernmost intersections, particularly for left turns leading in and out of the mall area. For instance, on a typical Saturday the westbound left turn at County Line Road experiences 197 split failures (or 85 percent of all cycles) during this time period on average. The southbound left movement at Greenwood Mall Entrance also has some challenges with an average of 78 split failures per day (33 percent of all cycles). This graphic provides mechanism to rapidly identify and locate movements with significant split failures across a large inventory of intersections.

How can my Agency Implement Performance Measures?

Interested engineers often ask the authors how they can start using SPMs and what the required elements are. The basic process is outlined as follows:

1. Implement data collection at desired intersections by installing a compatible controller with recent firmware and enabling the data collection features.

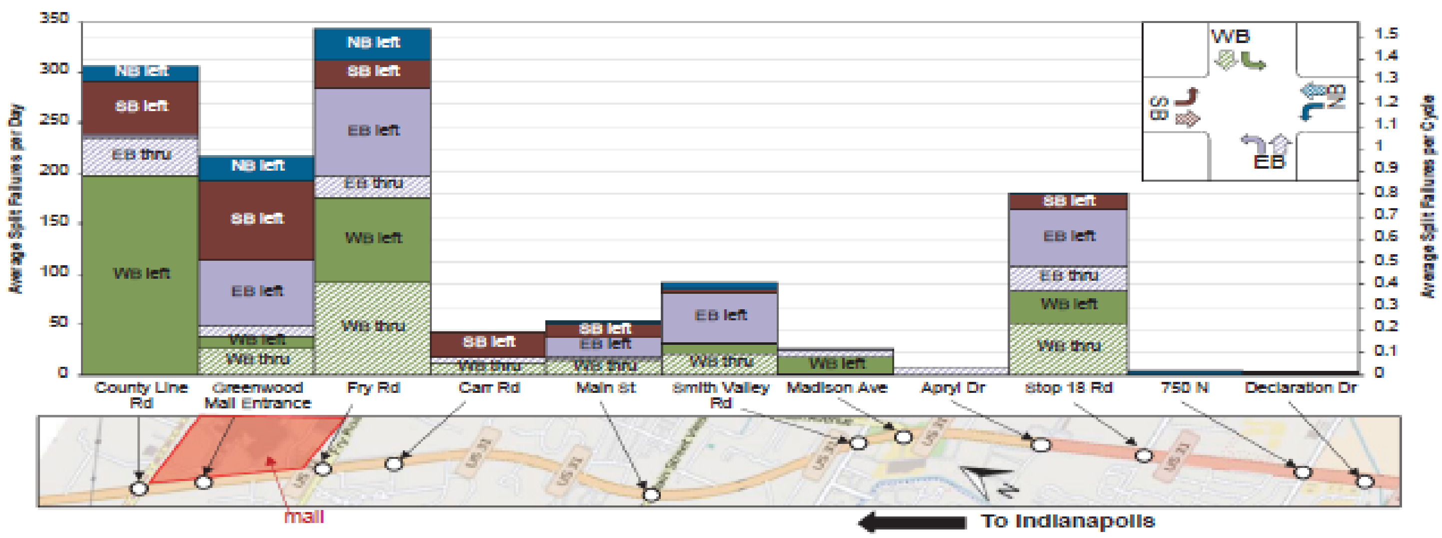

Figure 5. Split failures by intersection and movement on US 31, Greenwood, IN, USA. Data shown for January–June 2015, Saturdays, 11:00 a.m. to 7:00 p.m.

2. Install communication to the intersection to enable transfer of data. A variety of strategies are possible and range from dedicated fiber optic networks in Utah to the use of a Virtual Private Network (VPN) over cellular modem wireless internet protocol (IP) in Indiana.[15]
3. Establish a data collection process. This can be accomplished by setting up a scheduled task in a Linux or Windows server or workstation. Data files can be transferred by file transfer protocol (FTP) or manually retrieved at locations without communication. Individual vendors can provide a software utility to convert the files into comma-separated values (CSV) format, which can then be ingested into a database.
4. Implement a web service to calculate the SPMs and deliver them to users. A relatively simple way to quickly implement this would be to use the UDOT source code, which will be available through an open source platform in late 2016. Some central systems also offer this capability. Depending on the capability of the agency, it may be appropriate to hire a consultant to manage this process.
5. Maintain the data infrastructure over time. The process is not unlike managing data coming from intelligent transportation system (ITS) assets, but the volume of data for large traffic signal systems can potentially grow at a faster pace than aggregated ITS sensor data.

Future Development

Recent research has led to the development of a variety of metrics that have been demonstrated in several field studies, as mentioned earlier. One area of research is the integration of external data sets, such as video streams from detection systems, and probe data from third-party vendors, both of which can add considerable value to SPM dashboards. Another area of research is implementation. While several state agencies have been successful at implementing SPMs, there are many signal systems operated by local agencies, many of which have a smaller resource pool than the states. Moving forward, it will be essential to understand the barriers to entry for these states and find ways to mitigate these. A current NCHRP project (3-122) is aimed at articulating these needs for agencies of different sizes and capabilities and developing guidance for SPM implementation.[16]

Automated Traffic Signal Performance Measures have been selected by the Federal Highway Administration as an Every Day Counts Initiative for years 2017 and 2018.

Learn more: www.fhwa.dot.gov/innovation/everydaycounts/edc_4

did you know?

get involved

Purdue University, Utah Department of Transportation, Indiana Department of Transportation, and the City of College Station, TX, USA will conduct a Signal Performance Measures workshop at the ITE Annual Meeting & Exhibit in Anaheim, CA, USA for two consecutive sessions:

Tools for Better Decision-Making: Automated Signal Performance Measures
Developed by the ITE Traffic Engineering Council in collaboration with the National Operations Center of Excellence

Tuesday, August 16
Part 1: 1:00–3:30 p.m.
Part 2: 4:00–5:30 p.m.

This workshop will focus on tactical performance measures that can be used to identify opportunities for 1) improving arterial progression and 2) improving split (green time) allocation. The workshop will discuss high resolution controller data, how this data can be used to develop tactical performance measures, and outcome-oriented, probe data-based performance measures for validating that implemented timing changes are working.

Register for the ITE Annual Meeting & Exhibit at www.ite.org/annualmeeting.

Acknowledgments

This work was supported in part by UDOT, INDOT, Purdue University, the Traffic Signal Systems Operation and Management Pooled Fund Study (TPF-5(258)), the AASHTO Innovation Initiative, and the Joint Transportation Research Program. This paper reflects the views of the authors, who are responsible for the facts and the accuracy of the data presented and does not necessarily reflect the official views or policies of the sponsors. These contents do not constitute a standard, specification, or regulation. **itej**

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Chris Day, Ph.D. *is a senior research scientist with the Joint Transportation Research Program at Purdue University. His research has included numerous projects related to traffic signal systems operations and performance measures. Day holds a doctorate in transportation engineering from Purdue University and is a young member of the Transportation Research Board's Traffic Signal Systems Committee (AHB25).*

Mark D. Taylor, P.E., PTOE, *is the traffic signal operations engineer for the Utah Department of Transportation. He has worked in traffic signal operations for 16 years. He holds bachelor's and master's degrees from Brigham Young University. He is a member of ITE.*

Jamie Mackey, P.E., PTOE, *is a statewide signal engineer for the Utah Department of Transportation. She has worked in traffic signals operations for 11 years, in both Texas and Utah. Jamie has a bachelor of science from Iowa State University and a master of science from The University of Texas in Austin. She is a member of the Transportation Research Board's Traffic Signal Systems Committee and a member of ITE.*

Rob Clayton, P.E., PTOE, *is the director of traffic management for the Utah Department of Transportation. Rob has 22 years of experience in the field of transportation engineering, specializing in Traffic Operations. He holds bachelor's and master's degrees from Brigham Young University.*

Shital K. Patel, P.E., *is the manager of operations and project management with the Freeway and Arterial System of Transportation (FAST) at the Regional Transportation Commission of Southern Nevada. Has more than 20 years of experience in traffic engineering and operations. He has co-authored various transportation-related articles and journal papers. He is a member of ITE.*

Gang Xie, P.E., *is a senior project engineer for the Regional Transportation Commission of Southern Nevada (RTC) Freeway and Arterial System of Transportation (FAST). He has worked in freeway and signal operations, and performance measurement system development for 10 years. He developed the FAST Dashboard, which was named Project of the Year by the ITE Transportation Systems Management & Operations Council in 2011 and U.S. Department of Transportation Data Innovation Challenge Champion in 2014. He received his bachelor's and master's degree from Beijing Jiaotong University and a master of science in civil engineering from University of Nevada, Las Vegas. He is a member of ITE.*

Howell Li *is a senior software engineer at the Joint Transportation Research Program at Purdue University. He earned his Master of Science in May 2013 from Purdue and has published and co-authored on various papers in the Transportation Research Record on traffic signal management and operations. He holds a Bachelor's degree in Computer Science from New York University.*

James R. Sturdevant, P.E., *has worked in traffic operations for over 15 years and currently serves as Indiana Department of Transportation's Director of Traffic Management where he is responsible Freeway, Arterial, and ITS operations. James received his bachelor of science in Civil Engineering from the University of Colorado, is a licensed professional engineer in the State of Indiana, and is a member of ITE.*

Darcy Bullock, P.E., *is a professor in the School of Civil Engineering at Purdue University and serves as the Director of the Joint Transportation Research Program. Bullock has more than 25 years of experience in the field of transportation system operations.*